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THE PHILIPPINE
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STUDIES ON THE GEOGRAPHICAL DISTRIBUTION INCIDENCE, AND CONTROL OF SCHISTOSOMIASIS JAPONICA IN THE PHILIPPINES.[1]

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FIVE TEXT FIGURES

Schistosomiasis japonica is a fatal parasitic disease affecting man and other mammalian animals and caused by the blood fluke, *Schistosoma japonicum* (Katsurada). It is also called Asiatic or Oriental intestinal schistosomiasis because of its limited distribution in certain endemic areas in countries of the Far East. According to Faust and Meleney(7) it is probably an ancient disease, but its true nature remained unknown until the early part of the present century when Katsurada(12) discovered the causative agent in Japan and described it under the name *Schistosomum japonicum*. The following year Catto(5) and Logan(13) associated the same trematode with an ailment prevalent in some parts of China, and Stiles(23) recorded its

[1] Aided by a grant from the National Research Council of the Philippines. The writers wish to express their thanks to Director A. S. Argüelles of the Bureau of Science and to President B. M. Gonzalez, and Dean A. G. Sison, of the University of the Philippines, for their active support of these studies.

[2] Resigned July, 1939.

occurrence in the Philippines on the basis of material sent him by Woolley from Manila. In 1906 Woolley published his observations, which deal principally with the pathology of the infection. In 1915 Yokogawa found the parasite in Formosa and more recently Mueller and Tesch(16) and Brug and Tesch(4) reported it from Celebes.

Soon after the publication of Woolley's report, additional cases of schistosomiasis were encountered by other investigators working in Bilibid Prison and hospitals in Manila. A compilation of the earlier data by Mendoza-Guazon(14) showed that a large number of the cases came from Leyte, Samar, and Mindanao, indicating that these three islands are important sources of the infection. Thus far, however, only the former island has been definitely shown to be an endemic focus, as a result of the discovery by Tubangui(25) of a snail, *Blanfordia quadrasi* (Moellendorff)[3] in Palo, Leyte, which serves as the intermediary host of the helminth etiological agent.

The possible occurrence of schistosomiasis japonica in the other parts of the Philippines was pointed out recently by Africa and Garcia.(1) These investigators reported 4 cases, 2 of whom were suspected to have contracted the infection in the island of Mindoro and the other two either in Albay or Sorsogon Province. Confirmation of the existence of schistosomiasis in these places should lead to the supposition that the disease has either been spreading, or else it is more widely distributed than was formerly believed.

The studies reported in this paper were undertaken in order to determine more accurately the geographical distribution and incidence of the infection in the Philippines and to inquire into the advisability of instituting control measures. Although our observations are as yet far from complete, due to the lim-

[3] Specialists differ in their opinions on the systematic status of this snail. Rensch(21) first described it as *Oncomelania hydrobiopsis* sp. nov., but later(22) recognized its similarity with Moellendorff's *Prososthenia quadrasi*. Bequaert(3) identified it as *Blanfordia quadrasi* (= *Prososthenia quadrasi* Moellendorff). According to Bartsch(2) *hydrobiopsis* and *quadrasi* represent two distinct species of snails, and he has proposed the new genus *Schistosomophora* for them. Recently I forwarded to Doctor Bequaert for identification several batches of the same type of snail collected in Mindanao, Leyte, Samar, and Mindoro. In his reply Doctor Bequaert says: "Mr. Clench and I have very carefully compared all of these and we feel that they represent one and the same species, *Blanfordia quadrasi* v. Moellendorff."

ited time and funds at our disposal, we have decided to record them with the hope that they may at least serve to stimulate further investigation on this parasitism which, as will be discussed later, is a menace to the health of thousands of people living in the different endemic areas.

METHODS

The occurrence of the infection in a locality was ascertained by examining the fæces of some of the people, especially those showing suspicious symptoms of the disease, for the presence of the ova of *Schistosoma japonicum;* and/or by searching for the snail intermediate host of the parasite. In some places the fæces of domesticated animals were also examined. Some of the fæcal samples were examined within four or five hours after collection; the others were preserved in 10 per cent solution of commercial formalin and kept until our return to Manila. The latter were strained through a wire screen and then sedimented. In every case at least four slides were examined before a specimen was declared negative.

The search for *Blanfordia quadrasi* was made in all likely locations, such as in rice fields and on the banks of fresh-water streams, lakes, and irrigation canals or ditches. When found, samples of the snail were examined for the presence of the cercaria of *Schistosoma japonicum* and, if positive, infection experiments on laboratory rats were carried out for the purpose of recovering adult worms and their ova.

In some places other kinds of fresh-water mollusks, such as *Lymnæa philippinensis* and *Anisus* (*Gyraulus*) *convexiusculus,* were also examined, in view of the observation of Porter,(19) who found what was apparently the cercaria of *Schistosoma japonicum* in *Lymnæa natalensis* in Africa.

FINDINGS

INFECTED AREAS

Thus far our field studies have shown schistosomiasis japonica to be endemic in the islands of Leyte, Samar, Mindoro, and Mindanao (text fig. 1). Our findings thus confirm the earlier observations of Garrison(8) and Mendoza-Guazon,(14) and partly those of Africa and Garcia.(1) The infection, however, is not uniformly distributed in any one of these four islands, but is localized in certain isolated areas which are often very far apart.

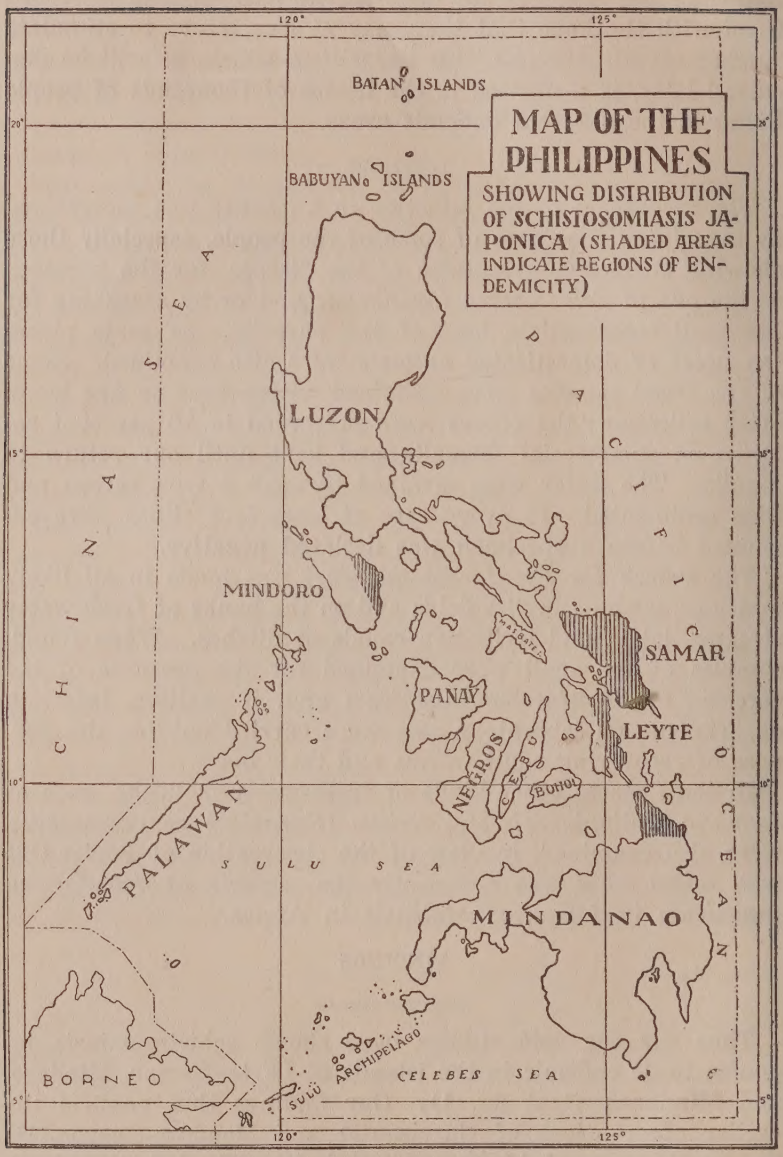

FIG. 1. General distribution of schistosomiasis japonica in the Philippines.

Leyte.—Leyte is one of the group of Visayan islands of the Philippine Archipelago located immediately southeast of Luzon Island. It lies between 9° 55′ and 11° 33′ north latitude and 124° 17′ and 125° 18′ east longitude. It has an area of about 7,250 square kilometers. The principal range of mountains runs from the northwestern part of the island to the southwestern extremity and divides the island into two parts, each of which has a distinct climate. In the eastern part there is practically no dry season, the greatest amount of rain falling in November or December. The average mean monthly temperature (average for 16 years) ranges from 25.6° C. in January to 27.6° C. in August. In the western part the annual rainfall is more evenly distributed, there being neither a dry season nor a very pronounced maximum rainy period. The average mean monthly temperature is from 24.9° C. in January and February to 27.5° C. in August.[4] The main industry of the island is agriculture and the principal products are abacá (Manila hemp), corn, copra, and rice.

The prevalence of schistosomiasis in Leyte is evidenced by the fact that nearly one-half of the total number of cases of the disease that have been recorded in the literature came from this island. The infection appears to be confined to the eastern half of the island, no cases having been reported from any of the towns in the western part (text fig. 2). Of the 4 cases reported by Hizon,(9) 2 were from Palo and 1 each from Tanauan and Burauen. Ramos(20) described 1 case from Dagami, and Ira-Concepcion(11) 1 case from Dulag. The cases reported by Africa and Garcia(1) were distributed as follows: 5 from Dagami, 4 from Palo, 11 from Tolosa, 2 from Tanauan, and 2 from Burauen.

As already mentioned, it was in Palo that the snail intermediate host of the parasite in the Philippines was first found by Tubangui.(25) In the present study we decided to look for the disease and the mollusk in Dagami and Dulag.[5] The former is an interior town while the latter is coastal; but both are

[4] The data on climate were obtained from The climate of the Philippines, published by the Department of Agriculture and Commerce, Manila (1939) 31 pp.

[5] We also made a brief survey in Baybay, a town on the western coast of Leyte, with the cooperation of Dr. Jose Mercado, President of the Sanitary Division of that municipality. No cases of the disease and no *Blanfordia* snails were found.

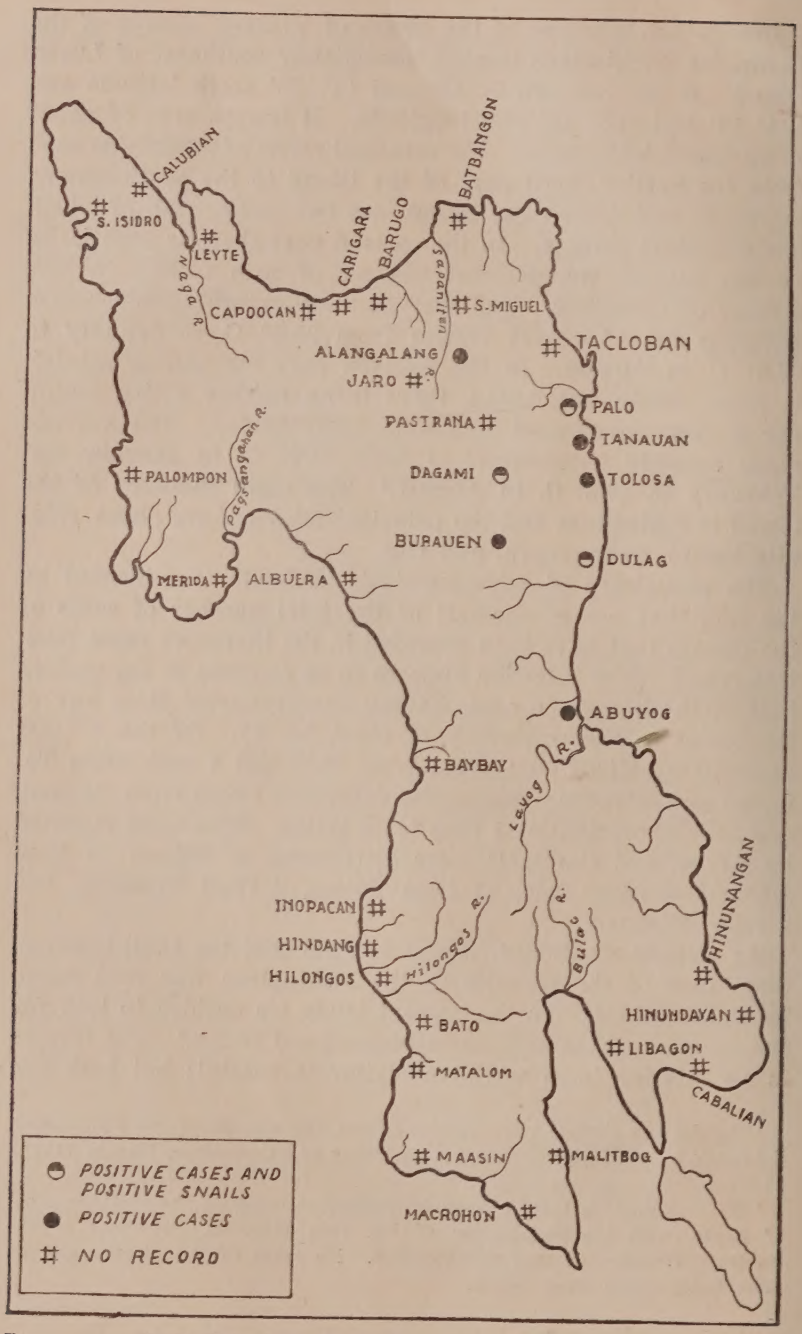

FIG. 2. Endemic centers of schistosomiasis japonica in Leyte.

rice-producing. No difficulty was experienced in finding cases in these two municipalities. After describing the disease to some of the people we were informed that an ailment locally known as "bagó" and characterized by enlargement of the abdomen, anæmia, and cachexia, is of common occurrence. The microscopic examination of the excreta of "bagó" cases showed the presence of schistosome eggs.

The search for the molluscan intermediate host did not prove difficult after cases had been found of the disease. The snail was easily located on the banks of streams and canals that were frequented by some of the infected individuals. In the población of Dagami were two boys who most probably contracted the disease by often going to a ditch not very far from the town church in order to catch mudfish. The ditch receives its water partly from the frequent rains and partly from seepage from the neighboring rice paddies, and discharges it into a fast-flowing stream. Large numbers of *Blanfordia quadrasi* were collected from the banks of this ditch on different occasions, of which from 2 to 5 per cent harbored the cercaria of *Schistosoma japonicum*. On the dikes of the neighboring rice fields, which at the time of our visit were flooded preparatory to plowing and planting, infected snails were also found.

In several other places in Dagami and in one barrio in Dulag, where there were cases of "bagó," the source of the infection was similarly traced to the presence of infected *Blanfordia quadrasi* in rice fields and irrigation canals. In Barrio Union, Dulag, we also found the snail in an old bed of a branch of the Dulag River that flows through the locality. During heavy rains, when the river is swollen, this bed becomes flooded; at other times it is kept moist by the seepage of water from the near-by rice fields.

Samar.—Samar Island is located immediately northeast of Leyte, being separated from the latter by the very narrow San Juanico Strait. It lies between 11° 01′ and 12° 42′ north latitude and 124° 15′ and 125° 50′ east longitude. It has an area of about 13,250 square kilometers. The surface is very rugged, but there is not a single mountain range that is sufficiently high to serve as a barrier to rain-laden winds. For this reason the climate is nearly uniform for the entire island and is similar to that of eastern Leyte. Due to the ruggedness of the soil only a small portion of the land is under cultivation. Rice is grown in the river valleys and coastal plains.

A review of the cases recorded in the literature shows that the areas of infection in Samar are more widely scattered than those in Leyte (text fig. 3). The case described by Phalen and Nichols(18) came from Calbayog, which is on the west coast, while that described by Nieva(17) was from Borongan, an eastern town. The cases reported by Africa and Garcia(1) were from towns along the western and northern coasts, namely: Catbalogan, Santa Margarita, Calbayog, Palapag, Catarman, and Laoang. Among the unpublished records of the Philippine General Hospital one of us (A. M. P.) encountered the names of patients whose stools were positive for schistosome eggs and who gave the towns of Calbiga, Gandara, Basey, and Bobon as their birthplaces.

We went to Samar in March, 1939, and stayed for two weeks in the Municipality of Calbiga. The town proper is located on a hill and on the banks of the river of the same name. Although the environment did not impress us as favorable for the successful propagation of schistosomiasis, we decided to examine as many of the people as were willing to submit fæcal samples. As a result we came across one case, a boy about 15 years old, who presented the clinical symptons of the disease and whose fæces showed the presence of schistosome ova. The boy informed us that he formerly resided in Barrio Canticum which is about 5 kilometers northeast of the población. We went to this barrio and found it to be hilly and sparsely populated. Between the hills, however, and the Calbiga River are rice fields under cultivation. A house-to-house survey of the people living near the provincial road enabled us to contact several clinical suspects, in whose fæces the characteristic eggs of *Schistosoma japonicum* were later found.

The only bodies of fresh water in the locality were a small mountain creek, from which the rice fields were irrigated, and a long canal that carried the water from the rice fields to a branch of the Calbiga River. These were searched carefully for the presence of *Blanfordia quadrasi.* The snail was not found in the rice fields nor on the banks of the creek; but on the banks of the canal, especially where it passed in front of a group of houses, it was present in large numbers. Of the several hundred snails collected, about 3 per cent were infected with the cercaria of *Schistosoma japonicum.*

Mindoro.—Mindoro Island lies directly south of the southwestern end of Luzon, between 12° 13′ and 13° 32′ north la-

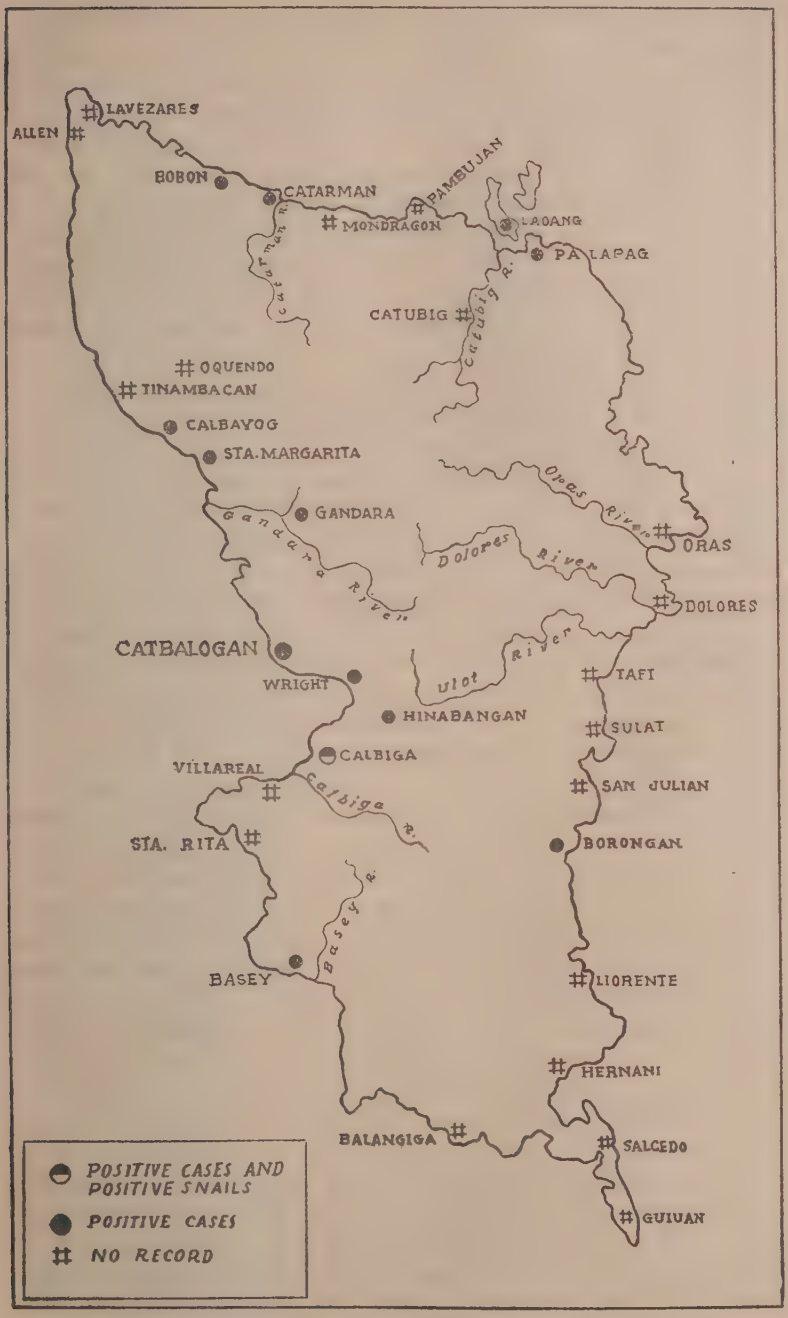

FIG. 3. Endemic centers of schistosomiasis japonica in Samar.

titude and 12° 18′ and 12° 34′ east longitude. It has an area of about 9,820 square kilometers. It is divided by a range of mountains into a western and an eastern part, each of which possesses a distinct climate. In the western part there are two pronounced seasons during the year, one dry and the other wet. In the eastern part the climate is similar to that of western Leyte. The island is traversed by numerous rivers, and in the northeastern part is Lake Naujan, a large fresh-water lake. The mountains are covered with valuable timber and the plains are fertile. Due, however, to the prevalence of malaria and other diseases, only a small portion of the land is under cultivation.

There are no available records by which it can be ascertained as to whether schistosomiasis has long been in existence in Mindoro or has been introduced only recently. The first intimation of the possible occurrence of the disease on the island was made only as late as 1935 by Africa and Garcia, who reported two cases, one of whom was suspected to have contracted the infection in Naujan and the other either in Pola or Bulalacao. The following year Torres(24) diagnosed one case from Naujan and treated it successfully with tartar emetic. In 1938 a male patient whose fæces were positive for schistosome eggs was registered in the Philippine General Hospital. When we went to Mindoro in May, 1939, we were able to locate the address of this person in Sitio Malayas, Naujan, but we were informed that he had died two months before our arrival. However, he had a younger brother whom we found confined in bed with symptoms of very advanced schistosomiasis and who died about a month after we saw him. Several other persons from the same neighborhood who were similarly affected were shown to us, and all of them were positive for schistosomiasis. The people believed, however, that the illness was due to malaria, this part of Mindoro being one of the worst malarious regions known in the Philippines, where the Philippine Bureau of Health maintains a malaria control unit. In conversation with Mr. C. M. Urbino, the entomologist in charge of the unit, we were told that a number of his malaria cases failed to show any physical improvement even after the prolonged use of quinine, and that the splenic index of the population was very high compared with the malaria-parasite index. Very likely the cases involved were mixed infections of malaria and schistosomiasis. Since quinine has no lethal

action on the blood fluke, a person with both malaria and schistosomiasis may be cured of the former but not of the latter disease by the administration of the drug. As to the splenomegaly, in both diseases, there is known to be a splenic enlargement, but in schistosomiasis it is accompanied by an enlargement of the liver.

All of the infected persons whom we encountered resided in Malayas and in the other sitios and barrios of the town of Naujan, located near the northern and western shores of the lake (text fig. 4). It was learned that while some of them were originally from Nueva Ecija, La Union, and other provinces in northern Luzon, the rest were natives of Mindoro who had never been outside of the island. There is therefore hardly any doubt that the disease was contracted locally, and it only remained for us to trace the source of the infection by finding the snail intermediate host of the parasite.

We searched for the mollusk in the part of Sitio Malayas between the Borbocolon and Malayas Rivers, where many of the infected individuals had their houses and their rice fields. The fields are irrigated from branches of the Borbocolon River, the excess water returning to the same river through a tortuous main canal. For one week we examined very carefully the banks of the streams and canals and some of the rice fields, but no snail having any resemblance to *Blanfordia quadrasi* was found. We collected and crushed other kinds of snails, but none showed the presence of the cercaria of *Schistosoma japonicum*. On the eighth day, after an unsucessful all-morning search and as we were about to return to our quarters, we asked our assistant, Mr. Pablo Rimando, to remain and to search further along the banks of the main canal. He had not gone one-hundred yards from where he left us when he reached a short secondary canal which was partially hidden by some banana trees and other vegetation. Nearby was an old house formerly occupied by a man whom we later found to be suffering from schistosomiasis. From the banks of this canal numerous specimens of *Blanfordia quadrasi* were collected, about 3 per cent of which harbored the cercaria of the blood fluke.

The examination of the excreta of some animals that were seen roaming at large in the neighborhood of the hiding place of the snail yielded interesting results. The animals examined were 6 dogs, 6 pigs, and 21 carabaos. Of the dogs, 2 (33.3 per cent) and of the pigs 3 (50 per cent) were positive for

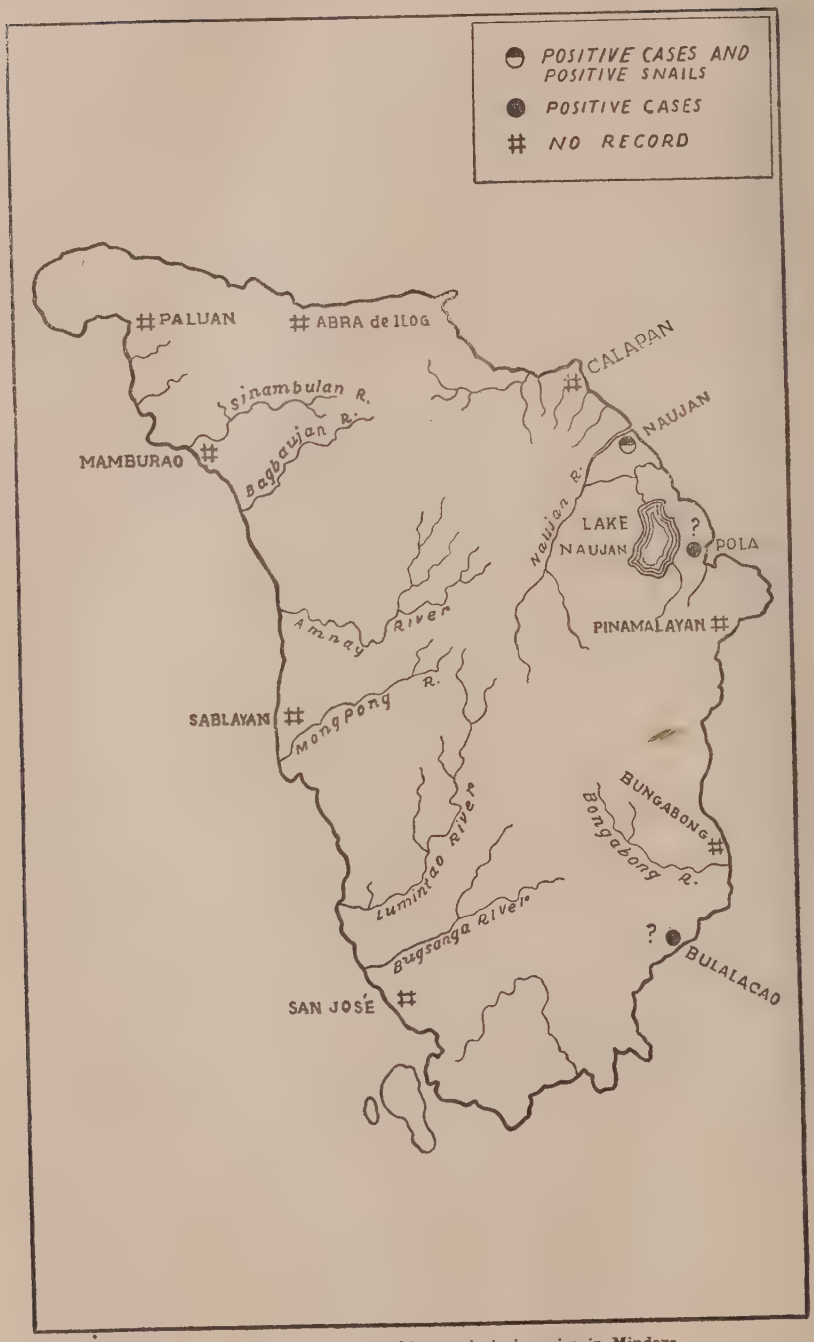

FIG. 4. Endemic centers of schistosomiasis japonica in Mindoro.

schistosome ova, but all of the carabaos were negative. As to whether or not the carabao is immune against the parasitism cannot be decided by the limited number of examinations made. In China the same type of animal has been found by Faust and Kellogg (6) and Wu(28) to be susceptible.

Mindanao.—Mindanao is the second largest island of the Philippine group, its area being about 95,520 square kilometers. It lies between 5° 33′ and 9° 48′ north latitude and 121° 53′ and 126° 36′ east longitude. It is divided into nine political subdivisions or provinces, namely: Surigao, Agusan, Davao, Bukidnon, Lanao, Cotabato, Oriental Misamis, Occidental Misamis, and Zamboanga. The climate varies in the different parts of the island, that in the eastern section being similar to the climate in Samar and eastern Leyte. Although mountainous, the island has several large fertile plains and valleys and level uplands. The principal agricultural products are hemp, corn, rice, and copra.

In 1908 Garrison found the eggs of *Schistosoma japonicum* in the fæces of four inmates of Bilibid Prison from Mindanao, but he did not state what part of the island the prisoners had come from. The information supplied by Hizon(9) and Africa and Garcia(1) is more definite, the former reporting 1 case and the latter 2 cases, all from Surigao Province. We have regarded the occurrence of schistosomiasis in this part of Mindanao as very probable after the demonstration by Tubangui(25) of the intermediate host status of *Blanfordia quadrasi,* since the type specimens of this snail, which were described by Moellendorff in 1895, were collected in Surigao, and since our observation has been that wherever the mollusk is found the disease is also present.

In April, 1938, we visited northeastern Mindanao by way of Surigao. We followed the main road from the capital of the province to the towns of Placer and Mainit, stopping at intervals of 2 to 3 kilometers to search for the snail. We found the mollusk, however, only when we reached the Surigao-Agusan road in Barrio Tubod, municipality of Mainit. At a place in Sitio Tuñgao, not far from the entrance to the camp of the Surigao Consolidated Mines, Incorporated, which is inhabited by a few families of rice farmers, *Blanfordia quadrasi* was present in large numbers on the banks of mountain creeks and irrigation canals and on the dikes of rice paddies. Of the several hundred specimens collected, about 4 per cent harbored

the larval stages of the Asiatic blood fluke. The examination of fæcal samples submitted by 33 of the adult inhabitants of the place showed a very high infection rate (45.5 per cent).

From the town of Mainit our two assistants, Pablo Rimando and Manuel Celestino, crossed Lake Mainit to Agusan to look for the same kind of snail. They spent four days in Jabonga and Cabadbaran. In the former town they collected *Blanfordia quadrasi* from the banks of a canal that passes in front of the Jabonga Elementary School and from a creek near the Mayugda Falls. In Cabadbaran they found the mollusk along a canal near the provincial road going to Butuan, about 12 kilometers from the poblacion.

Search for the snail was also made in the towns of Balingasag and Gingoog, Oriental Misamis Province, but with negative results. We included this part of Mindanao in our survey in view of the information given by Houghton(10) that the greater part of northern Mindanao is endemic territory. It appears from our data, however, that the disease occurs only in the northeastern part of the island, around the shores of Lake Mainit (text fig. 5).

OTHER PLACES VISITED

The question is often asked as to whether or not schistosomiasis is endemic in Luzon, because the disease has been met with in persons who gave Manila or one of the neighboring provinces as their places of residence, thereby creating the impression that they contracted the infection somewhere in Luzon. In order to be able to answer the question, surveys were made in and around Manila and in several places in Rizal, Bulacan, Nueva Ecija, and Sorsogon Provinces. In all of these places fæcal examinations were made on school children and adults, but not a single case of schistosomiasis was encountered. The search for the presence of *Blanfordia quadrasi* and any other mollusk that might be capable of playing the rôle of intermediate host to *Schistosoma japonicum* also yielded negative results. In Manila Africa and Garcia(1) have also searched unsuccessfully for a snail host, and we concur with their opinion that:

> The endemicity of schistosomiasis in Manila is only apparent as disclosed by our analysis of the registered cases in this city. . . As Manila draws a considerable portion of her population from the provinces, it is very doubtful whether these cases really contracted their infestations in the city or its immediate environs. In the majority of these cases no

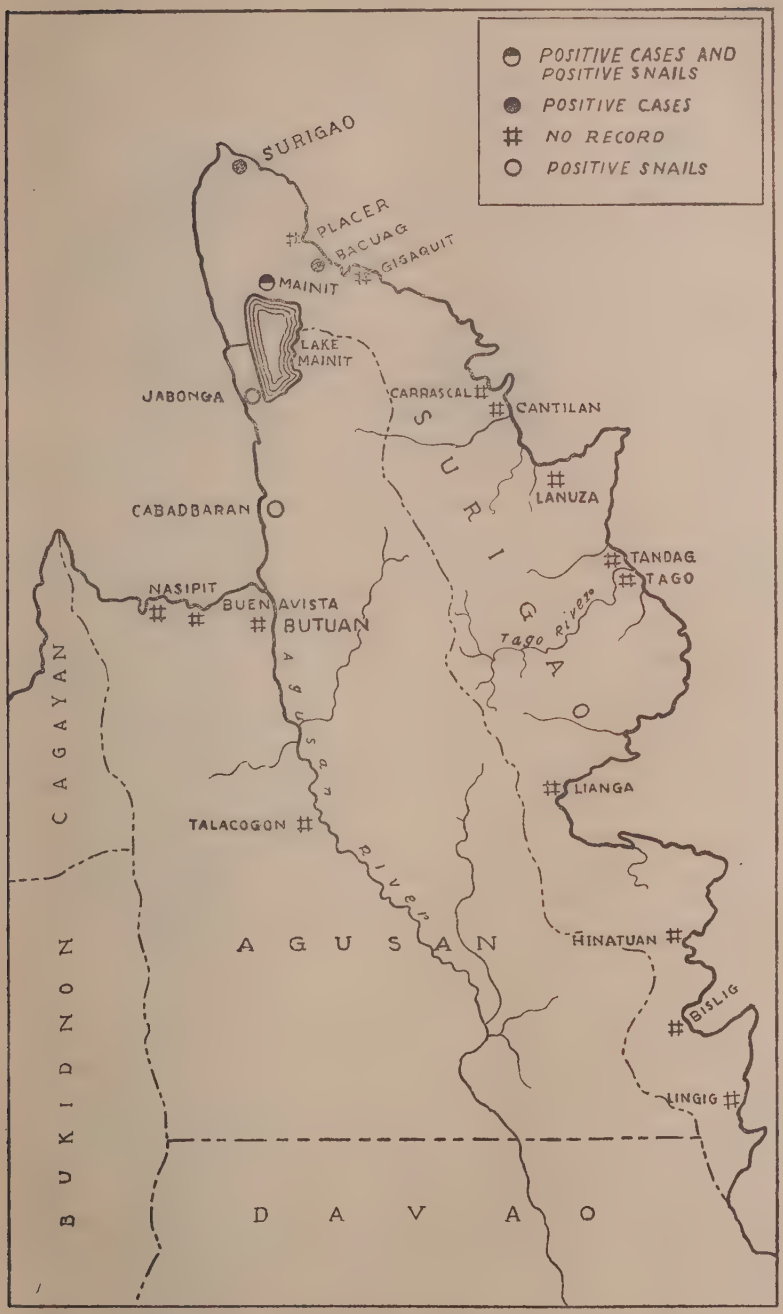

FIG. 5. Endemic centers of schistosomiasis japonica in Mindoro (northeastern part).

mention of their nativity was made in their case histories; they were merely recorded as laborers residing in the districts (of Manila) mentioned at the time of death. Manila is in all probability a non-endemic center. Our failure to collect snails similar or allied to the confirmed intermediate host in Leyte supports our contention.

If it were possible to trace the complete histories of the various cases reported from Luzon, the persons concerned would probably be found to have at one time or another been to some of the well-known endemic areas. For example, it has been found, according to Doctor Africa, that the case reported by Africa and Garcia(1) as coming from Bigaa, Bulacan Province, was a male student who spent one summer vacation in Samar. Willets's(26) case from La Union and that of Dr. W. de Leon from the same province, as reported by Africa and Garcia, were very likely natives of that province who had emigrated to Mindoro. During our visit to that island we met a number of rice farmers who came from La Union Province, many of whom were affected with schistosomiasis. If these persons should go to a hospital or to a private physician for treatment, in the course of the usual clinical history writing they would naturally mention their native towns as their places of birth.

Quite recently, through the courtesy of Dr. W. Vitug, we were shown two female patients in the Philippine General Hospital, both of whom were positive for schistosomiasis. One of them was a native of Bulan, the other of Gubat, Sorsogon. We questioned these patients repeatedly regarding the different places they had visited and the information they always gave us is that outside of their home province they had only been in Manila and in Baguio, Mountain Province. When we went to Sorsogon, however, we learned from their immediate relatives that one of them had stayed in Samar for at least one year and the other in Masbate and Leyte.

FACTORS PROBABLY INFLUENCING THE DISTRIBUTION OF THE SNAIL AND THE DISEASE

Mention has been made of the fact that the endemicity of schistosomiasis japonica in a locality depends entirely upon the presence of a suitable snail intermediate host. The question then arises: What factors are responsible for the distribution of *Blanfordia quadrasi* in the Philippines? We do not think we have found a complete answer to this question, but we have gathered data that may have something to do with it.

To begin with, it has already been stated that *Blanfordia quadrasi* is amphibious in its habits, being most frequently found, when it is not submerged in the water, on the constantly moist banks of small, slowly-flowing streams and irrigation canals or ditches. There are two factors in the endemic territories which help to keep the environment constantly moist. One of these is the climate which is characterized by the absence of a dry season and the more or less uniform distribution of the annual rainfall. The other factor is the location of the favorite sites of the mollusk in regions that are low and subject to frequent overflows, such as along the beds of rivers and the shores of lakes. The infected places around Lake Naujan in Mindoro and Lake Mainit in Mindanao are typical examples.

If, however, the conditions influencing the distribution of *Blanfordia quadrasi* were solely due to climate and topography, the snail as well as the disease could be expected to occur in other islands or provinces, such as Albay, Sorsogon, Camarines Norte, Camarines Sur, and in the other parts of Luzon and Mindanao where there are also frequent rains throughout the year and no dry season. Up to the present, however, no authentic cases of schistosomiasis have been reported from these places, and attempts to find the snail have thus far failed, indicating that there may be other factors involved in the distribution of the mollusk. The existence of these other factors appeared the more probable in view of the observation that even in the same endemic area there are places which are apparently avoided by the mollusk.

Suspecting that the chemical composition of the soil might have some influence, we collected three sets of soil samples from different places. One set composed of samples 1 to 5 were taken from the banks of streams and canals in infected areas where *Blanfordia quadrasi* was found; a second set, samples 6 to 8, was collected from similar locations in endemic territories where the snail was not encountered; and a third set, samples 9 to 10, was obtained from banks of irrigation canals in noninfected regions. These were analyzed for us in the soil laboratory of the Department of Agriculture and Commerce through the kindness of Dr. M. M. Alicante, chief of the Division of Soil Survey. The results of the analyses are shown in Table 1. In general the soil samples taken from places where the snail was found have slightly lower pH values, higher nitrogen and organic carbon contents, and lower calcium percentages than those obtained from places where the mollusk was absent.

TABLE 1.—*Chemical composition of soil samples collected from endemic and nonendemic areas.*

Sample.	Origin of sample.	Chemical composition.							Remarks.
		pH value.	Organic C.	N	P_2O_5	K_2O	CaO	MgO	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	Calbiga, Samar	5.86	6.31	0.50	0.12	0.06	1.63	1.96	*Blanfordia quadrasi* found.
2	Dagami, Leyte	5.76	2.12	0.20	0.21	0.08	2.45	1.10	Do.
3	Mainit, Surigao	5.65	3.39	0.34	0.26	0.27	1.27	1.02	Do.
4	----do----------	5.84	2.22	0.22	0.25	0.24	1.46	1.18	Do.
5	Naujan, Mindoro	5.98	4.93	0.49	0.18	0.19	2.49	------	Do.
6	Calbiga, Samar	6.26	1.82	0.16	0.08	0.08	3.00	1.41	*Blanfordia quadrasi* not found.
7	Mainit, Surigao	5.98	1.93	0.20	0.18	0.48	2.88	1.50	Do.
8	Naujan, Mindoro	6.18	1.24	0.13	0.06	0.23	2.44	------	Do.
9	Baybay, Leyte	5.91	1.97	0.17	0.16	0.11	3.13	1.37	Do.
10	Gubat, Sorsogon	5.25	2.11	0.22	0.11	0.39	3.85	------	Do.

These differences in themselves may have but little significance, but in conjunction with climatic and other factors they may play an important rôle in creating a favorable environment for the mollusk. The high nitrogen and organic carbon contents denote the presence of a large amount of organic matter, on which the snail probably subsists. The low calcium content may be due to the fact that this element is utilized by the snail in building its shell.

INCIDENCE OF THE INFECTION

The results of the fæcal examinations in the different endemic places visited are summarized in Table 2. Of the 844 persons examined, 192, 22.7 per cent, were positive for *Schistosoma japonicum*. In some localities the infection percentages are rather high due most probably to the small number of people examined, the majority of whom were obviously suffering from the disease and presented themselves voluntarily with the hope of receiving treatment. If these selected cases are discarded, the general incidence is about 20 per cent. This figure is believed to be a very fair estimate of the prevalence of schistosomiasis among the rural population in the endemic territories. The term "rural" is here used to denote those persons, especially rice farmers, who live and work under conditions that expose them to the disease. In many thickly populated rice districts in Leyte the incidence of the infection is higher. In Mindoro

TABLE 2.—*Incidence of Schistosoma japonicum among persons examined in different endemic localities in the Philippines.*

Locality.	Number of persons examined.	Persons positive.	
		Number.	Per cent.
Leyte:			
Dagami—			
Poblacion	76	13	17.1
Guinerona	62	18	29.0
Bolirao	58	13	22.4
Buntay and other sitios	16	10	62.5
Abuyog	2	2	100.0
Burauen	4	4	100.0
Samar:			
Calbiga, Canticum	81	15	18.5
Hinabañgan	1	1	100.0
Wright	1	1	100.0
Mindoro:			
Naujan, Malayas	510	100	19.6
Mindanao:			
Surigao—			
Mainit, Tuñgao	33	15	45.5
Total	844	192	22.7

and Samar it tends to be lower, due probably to the sparse population of the infected areas.

The results of the examinations in Naujan, Mindoro, may be used to illustrate the age and sex distribution of the parasitism. Our data for the other places cannot be utilized for that purpose due to the small number of people examined. As shown in Table 3, of the 510 persons examined in Mindoro, 291 were males and 219 females. The infection percentage in the males was 23.7 per cent, in the females only 14.1 per cent. The infection percentage was lowest in children of both sexes who were not over 10 years old. It was highest in males between 11 and 30 years of age and in females between 11 and 20 years of age. In the older age groups the incidence was slightly lower and more or less uniform throughout, but it was always higher in the males than in the females. These differences may be explained if one recalls the manner by means of which infection with *Schistosoma japonicum* is brought about, namely, by the penetration through the skin or mucous membrane of infective cercariæ which are present in infected water. Male persons are generally more exposed to the disease because their occupations, such as rice farming, catching fish, digging canals, and the like, bring them in more frequent contact with bodies of water where the infection may be acquired.

TABLE 3.—*Infestation with Schistosoma japonicum in persons examined in Sitio Malayas, Naujan, Mindoro, arranged in age and sex groups.*

	Males by age groups.						Total.
	1–10	11–20	21–30	31–40	41–50	51+	
Number of persons examined	42	62	68	45	41	33	291
Number positive	4	19	21	11	8	6	69
Per cent positive	9.5	30.6	30.9	24.4	19.5	18.5	23.7
	Females by age groups.						Total.
	1–10	11–20	21–30	31–40	41–50	51+	
Number of persons examined	32	54	56	35	22	20	219
Number positive	1	13	7	6	2	2	31
Per cent positive	3.1	24.1	12.5	17.1	9.1	10	14.1

Males between the ages of 11 and 30 and females between the ages of 11 and 20 years are usually more actively engaged in these occupations than at any other time of their existence, and for that reason they are more likely to contract the infection. The lowering of the incidence in the older age groups is very likely brought about by the death of some of those individuals who contracted the disease during early life.

PROBABLE NUMBER OF PEOPLE WITH SCHISTOSOMIASIS

Before an accurate estimate of the number of people in the Philippines who are infected with *Schistosoma japonicum* can be made, it will be necessary to carry out specific epidemiological surveys in many more places than we have been able to visit. At present only a rough calculation is possible, based on the incidence data we have gathered and on our present knowledge of the distribution of the disease. According to the 1939 Census of the Philippines the total of the combined populations of the known infected localities in Leyte, Samar, Mindoro, and Mindanao is about 1,000,000 people. Of these, from one-eighth to one-sixth, or from 125,000 to 166,000, live under rural conditions and are therefore predisposed to the infection. If the incidence is 20 per cent, there are from 25,000 to 33,000 persons in the known endemic regions who harbor the Asiatic blood fluke.

The significance of the above figures from the health standpoint is too obvious for discussion. It should be emphasized, however, that a large number of the unfortunate victims are persons who should be most actively engaged in rice farming

and other gainful occupations. Instead, due to physical disability and increasing weakness and other effects of the infection, they are compelled to remain idle and to be dependent economically upon their families for the rest of their lives. The parasitism is thus a medical and a sociological problem which should be attended to as early as possible.

PROPHYLACTIC CONSIDERATIONS

The infection may be prevented by the institution of measures calculated to bring about the destruction of the causative agent during one or another stage of its life cycle and to prevent its entrance into the human body. These measures may be employed singly or in combination, the choice depending upon the local conditions, the habits of the people, and the facilities available. The following are the principal stages in the development of the Asiatic blood fluke and the methods that may be used to destroy them:

1. *The adult parasite in man.*—Specific drugs, like potassium or sodium antimony tartrate and fuadin, have been found effective in killing the parasite and curing the disease during the earlier stages of the infection. Very advanced cases, where the function of the liver has been much impaired due to extensive cirrhosis, are practically incurable. Tartar emetic or its sodium homologue is injected intravenously in the form of a freshly prepared aqueous solution, while fuadin is administered intramuscularly. These drugs have been used extensively in Egypt for the control of schistosomiasis hæmatobia and schistosomiasis mansoni.

2. *The eggs with their contained miracidia in the fæces of infected persons and other mammalian hosts.*—The proper disposal of human excrement through the avoidance of promiscuous defæcation and the use of sanitary privies will prevent schistosome eggs from reaching a body of fresh water, hatching there, and infecting the snail intermediate host. In places like China, where the use of human fæces as fertilizer seems to be an absolute necessity, the excreta should be stored in appropriate containers for a certain length of time before it is spread in the fields, in order to kill the miracidia in the eggs through a natural process of fermentation. Domesticated animals and other mammals which are susceptible to the blood fluke must be eliminated or their movements restricted so that they will not scatter the eggs with their fæces.

3. *The larval stages of the parasite (sporocyst and young cercaria) within the molluscan intermediate host.*—The destruction of the larval stages of the parasite within the intermediate host can be brought about and their development prevented by the elimination of the snail carriers. In Japan attempts to exterminate the molluscan intermediate host of *Schistosoma japonicum* by the use of chemicals and heat have been in progress during the last twenty years, and, according to Miyajima,(15) satisfactory results are being obtained. The chemical employed is unslaked lime (CaO) because of its low cost. It is lethal in 0.1 per cent concentration not only to the snails but also to the infective cercaria. Heat is applied in the form of boiling water, which is either simply sprayed over the snails, or, in order to conserve the heat better, pumped from a boiler through a hose and expelled beneath a piece of heavy canvas spread over the ground where the mollusks are located.

4. *The liberated cercaria.*—The mature cercaria which escapes into the water from the snail intermediate host is the infective stage in the life cycle of the blood fluke. Its entrance into the human body may be prevented by killing it with a chemical like quicklime or by people not immersing themselves in infected water. Those whose occupations compel them to work in the water, should use appropriate coverings. In Japan the rice farmers are advised to cover the skin of the extremities with a double layer of cotton cloth with a mesh of not over 100 microns or to apply a coating of heavy oil or grease. High rubber boots are the best protection for the feet, but they are cumbersome and many farmers cannot afford to buy them.

CONTROL MEASURES RECOMMENDED

The control of schistosomiasis japonica in the Philippines should not be difficult to undertake, due to the localization of the disease in a few islands that are easily accessible. Since, however, due to financial considerations and the possible lack of adequate personnel, it may not be feasible to carry out immediately extensive campaigns in the different endemic areas, it may be better and more economical in the long run to begin in a number of small selected communities, in order that the experience thus gained may be utilized to advantage in the other infected places. The following control measures are recommended:

Educational propaganda.—In order to secure the intelligent cooperation of the people, it is of paramount importance that they should first be enlightened on the nature and mode of propagation of the disease. For this purpose, popular articles and illustrations on schistosomiasis should be prepared and explained to the people by trained lecturers through the medium of the schools, clinic centers, the radio, and other available agencies. Special emphasis should be placed on the following:

Avoidance of indiscriminate defæcation in the fields, especially near streams and canals.—The present campaign of the Philippine Bureau of Health, which requires every house to have a sanitary toilet, if intensified in the endemic territories and if the people can be convinced to use their toilets, will accomplish this object.

Avoidance of contact with infected water.—With few exceptions, the most important sources of the infection are streams and irrigation canals or ditches which people visit in order to catch fish or to wash after working in muddy fields, or which they cross in going from one place to another. These should be marked dangerous by means of conspicuous signs and people should be advised not to immerse themselves in the water. If they are on the way, bridges should be built so that in crossing them the people will not wet their feet. Those who work in rice fields believed to be infected should use hand and foot coverings.

Elimination of reservoir hosts.—In the Philippines the only animal used in rice cultivation is the water buffalo or carabao (*Bubalus bubalus* Linn.). This animal, however, does not appear to be an important reservoir host of the blood fluke. Dogs and pigs, on the other hand, have been found to be infected with the parasite and must be confined and not allowed to roam at large.

Establishment of treatment centers.—The treatment of the disease with specific drugs like tartar emetic or fuadin should be undertaken in the different endemic areas. This treatment will serve three useful purposes: (*a*) it will lessen the rate of mortality and economic loss from the disease; (*b*) it will reduce the number of people passing schistosome eggs and thus diminish the chances of propagating the infection; and (*c*) it will be a means of gaining the confidence of the people and obtaining their coöperation in the carrying out of the other preventive measures.

Extermination of the snail intermediate host.—A sound knowledge of the bionomics of *Blanfordia quadrasi* is an important prerequisite in attempts to practice control measures. Our observations have shown that the adult snail is truly amphibious in character, being found either in the water or on the constantly moist banks of irrigation canals and other small bodies of fresh water. In the water it may be killed by the use of such well-known poisons as copper sulphate or unslaked lime. On the ground it may be killed by means of heat. A good source of heat besides boiling water is the blaze of a portable torch or burner. In carrying out this control measure, the harborages of the mollusk must be accurately determined. These should be given heat treatment at intervals of a few days until the total disappearance of the snail.

SUMMARY AND CONCLUSIONS

1. The present studies were undertaken to determine more accurately the geographical distribution and incidence of schistosomiasis japonica in the Philippines and to inquire into the advisability of instituting prophylactic measures.

2. Surveys were made in those islands and provinces from which cases of the disease have been recorded in the literature. The existence of the infection in a locality was ascertained by examining the fæces of some of the people and sometimes of domestic animals for the presence of the ova of *Schistosoma japonicum* and/or by searching for the snail intermediate host of the parasite.

3. One or more areas of infection were found in Leyte, Samar, Mindanao, and Mindoro; none were found in Manila and in Bulacan, Nueva Ecija, Rizal, and Sorsogon Provinces. The cases of schistosomiasis appearing in the literature as having come from the latter places must have contracted the infection in one of the above-mentioned islands.

4. In Leyte the infection seems to be confined to the eastern half of the island, while in Samar it appears to be more widely distributed; in Mindoro and Mindanao it was found near the northeastern coasts, around Lakes Naujan and Mainit, respectively.

5. The determining factor in the distribution of schistosomiasis is the snail intermediate host; in other words, the disease is endemic only in places where the mollusk is found.

6. The snail is either in the water or on the constantly moist banks of small, slow-flowing fresh-water streams and irrigation canals where there is an abundance of decaying organic matter for the sustenance of the mollusk. Among the factors that help to maintain a favorable environment for the snail are probably climate and topography as well as the chemical composition of the soil.

7. The incidence of schistosomiasis in the different infected localities visited varied from 17.1 to 45.5 per cent, the average being about 20 per cent; it was higher in Leyte than in Samar or Mindoro.

8. The disease is a menace of medical and economic importance in the Philippines due to the large number of people affected, many of whom either succumb or are disabled physically.

9. The following control measures are recommended:

(*a*) *Educational propaganda.*—The object is to enlighten the people on the danger of promiscuous defæcation, the rôle of domesticated animals and other reservoir hosts in the propagation of the disease, and the methods of protecting the body from cercarial invasion.

(*b*) *Specific treatment of the disease.*—This treament will serve to lessen the rate of mortality from the infection, diminish the chances of propagating the malady by reducing the number of people passing schistosome eggs, and gain the confidence and active coöperation of the people.

(*c*) *Extermination of the snail intermediate host.*—This may be accomplished by the use of chemicals and heat.

10. Further studies should be made (*a*) on the disease in order to increase our knowledge of its geographical distribution and to determine whether it is spreading; and (*b*) on the snail intermediate host with special reference to its life history and bionomics.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. General distribution of schistosomiasis japonica in the Philippines.
2. Known endemic centers of schistosomiasis japonica in Leyte.
3. Known endemic centers of schistosomiasis japonica in Samar.
4. Known endemic centers of schistosomiasis japonica in Mindoro.
5. Known endemic centers of schistosomiasis japonica in Mindanao (northeastern part).

A COLLECTION OF LONGICORN BEETLES FROM THAI

COLEOPTERA: CERAMBYCIDÆ [1]

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ONE PLATE

The following descriptions and records of longicorn beetles from Thai (Siam) are based on part of a collection sent to the writer for study by Mr. W. S. Fisher of the United States Bureau of Entomology and Plant Quarantine at Washington, D. C. This collection consisted of miscellaneous small lots collected by various people, but mostly taken by Dr. Hugh M. Smith in northern Siam and at Bangkok, and by Dr. W. L. Abbott at Trong in lower Siam. Four new species are described in this contribution, all of them having been collected by Dr. Hugh M. Smith, and two others were described in an earlier article.[2] The types of the new species, and the other listed specimens, are in the collection of the United States National Museum in Washington, D. C., except for a few duplicates in the writer's collection. The writer is deeply indebted to Mr. W. S. Fisher and Dr. E. A. Chapin of the United States National Museum for the privilege of studying and reporting upon this material.

At the end of the enumeration of the species in the present collection is appended a list of the species of Cerambycidæ so far recorded from Siam. These number but slightly over one hundred species, which is strikingly few, considering the thousands of species that have been described from India, Burma, Indo-China, South China, and the Malay Peninsula and Archipelago. Many of these, of course, are to be expected in Thai, as there is no small number of well-known species which have been recorded from one or more parts of the Malay region as well as from Burma, Tenasserim, or some other area north of Thai.

[1] Contribution from the Lingnan Natural History Survey and Museum, Lingnan University.

[2] New longicorn beetles from the Philippines, Borneo and Siam. Philip. Journ. Sci. 58 (1935) 267–280.

PRIONINÆ

PHILINI

Genus **PHILUS** Saunders, 1853

1. PHILUS COSTATUS Gahan.

Philus costatus Gahan, Ann. & Mag. Nat. Hist. (6) 11 (1893) 254.

Several examples were collected at Bangkok by Dr. Hugh M. Smith. Specimens in the United States National Museum and in my collection.

DISTENIINÆ

DISTENIINI

Genus **DISTENIA** Serville, 1825

2. DISTENIA FULVIPENNIS Gressitt.

Distenia fulvipennis Gressitt, Philip. Journ. Sci. 58 (1935) 267.

Known only from the type specimen in the United States National Museum, collected at Chiengmai April 7, 1928, by Dr. and Mrs. J. W. McKean.

LEPTURINÆ

LEPTURINI

Genus **OCALEMIA** Pascoe, 1858

3. OCALEMIA AUREOVIRIDIS Gressitt sp. nov.

Elongate, posteriorly attenuate; metallic green with bronzy iridescence; antennæ black beyond scape; legs cyaneous, tarsi black; dorsal surface, including antennæ and legs, clothed with short, stiff, inclined, black bristles; scutellum and ventral surfaces of body silvery pubescent.

Head long; eyes subglobular, prominent; neck suddenly constricted behind eyes; occiput densely and finely punctured; frons with a triangular impunctate area; clypeus large, heavily punctured; genæ large, sparsely punctured. Antennæ reaching to last fifth of elytra, thickened distally; scape as long as fourth segment and three-fourths as long as third; fifth segment subequal to third, sixth to tenth segments gradually shorter; bristles longest on inner side of third to fifth segments. Prothorax barely longer than broad, broadest basally, slightly swollen at middle, strongly constricted behind anterior margin which is two-thirds as broad as base; basal margin slightly raised, concave on each side of middle; disc rather finely and densely punctured, a small oval impunctate area near base. Scutellum scutiform. Elytra narrow, twice as long as head and protho-

rax combined, constricted antemedially, slightly narrowed and interno-obliquely truncated apically; surface densely and deeply punctured. Ventral surfaces densely and finely punctured, more sparsely so on apical portions of abdominal segments. Legs long; hind tibiæ arched, shorter than their tarsi, which are laterally compressed and have the first segment as long as the remaining segments united.

Length, 14 to 15 millimeters; elytra, 9 to 9.5; breadth, 2.4.

Holotype, female (United States National Museum), Khun Tan Mountains, northern Siam, May 1933, Dr. Hugh M. Smith; female paratopotype in my collection.

This species is closely related to *O. prasina* Heller, of Luzon, differing in lacking red on its femora and antennæ, in having the head and prothorax more densely punctured, and in other respects. Differs from *O. viridescens* Pic, of Laos, from the brief description, in having the head and ventral surface green, and the legs blue instead of black.

CERAMBYCINÆ

HESPEROPHANINI

Genus STROMATIUM Serville, 1834

4. STROMATIUM LONGICORNE (Newman).

Arhopalus longicornis NEWMAN, Entomologist 1 (1842) 246, Philippines.

Stromatium longicorne WHITE, Cat. Col. Brit. Mus. 8 (1853) 300.

Specimens were collected at Bangkok by Dr. Hugh M. Smith and are now in the United States National Museum.

Genus GNATHOLEA Thomson, 1861

5. GNATHOLEA EBURIFERA Thomson.

Gnatholea eburifera THOMSON, Essai Class. Ceramb. (1861) 375, Cambodia; GAHAN, Fauna Brit. India Col. 1 (1906) 111.

One specimen was collected at "Secchol, Siam" by Dr. Hugh M. Smith.

CERAMBYCINI

Genus ÆOLESTHES Gahan, 1890

6. ÆOLESTHES INDUTA (Newman).

Hammaticherus indutus NEWMAN, Entomologist 1 (1842) 245, Philippines.

Æolesthes induta GAHAN, Ann. & Mag. Nat. Hist. (6) 6 (1890) 253; Fauna Brit. India Col. 1 (1906) 128.

One specimen was taken at Bangkok by Dr. Hugh M. Smith.

CALLIDIOPSINI

Genus CERESIUM Newman, 1842

7. CERESIUM GENICULATUM White.

Ceresium geniculatum WHITE, Cat. Col. Brit. Mus. 8 (1855) 245, East Indies; GAHAN, Fauna Brit. India Col. 1 (1906) 158.

Some specimens were taken at Bangkok by Dr. Hugh M. Smith.

CALLICHROMINI

Genus PACHYTERIA Serville, 1833

8. PACHYTERIA VIRESCENS Pascoe subsp.?

Pachyteria virescens PASCOE, Proc. Zool. Soc. London (1866) 519, pl. 43, fig. 2, Penang.

One specimen was taken at Khow Sai, Trong, lower Siam, by W. L. Abbott, and is now in the United States National Museum.

Genus POLYZONUS Castelnau, 1840

9. POLYZONUS PRASINUS (White).

Promeces prasinus WHITE, Cat. Col. Brit. Mus. 7 (1853) 170, India.
Polyzonus prasinus GAHAN, Fauna Brit. India Col. 1 (1906) 219.

Some specimens were collected at Bangkok by Dr. Hugh M. Smith and are in the United States National Museum. This is apparently the first record for this country.

PYRESTINI

Genus PACHYLOCERUS Hope, 1834

10. PACHYLOCERUS SULCATUS Brongniart.

Pachylocerus sulcatus Brongniart, Nouv. Archiv Mus. Paris (3) 3 (1891) 240, pl. 10, fig. 4.

One specimen was collected at Bangkok by Dr. Hugh M. Smith and is in the United States National Museum.

CLYTINI

Genus CHLOROPHORUS Chevrolat, 1863

11. CHLOROPHORUS RUBRICOLLIS (Castelnau & Gory).

Clytus rubricollis CASTELNAU and GORY, Monogr. Genre *Clytus* (1841) 88, pl. 16, fig. 102.

Coloclytus rubricollis GAHAN, Fauna Brit. India Col. 1 (1906) 265.

A specimen was collected at "Sarakam, E. Siam" by Dr. Hugh M. Smith, and is in the United States National Museum. New to Thai.

12. CHLOROPHORUS SMITHI Gressitt sp. nov. Plate 1, fig. 1.

Largely black, clothed with sulphur-yellow pubescence above and paler-yellow pubescence below; marked above with black

as follows: prothorax with three large round spots in a transverse row, centered slightly before middle, elytra with a subcircular mark at base touching humeral angle and external margin, a subtransverse band at middle, sinuous anteriorly, extending forward a short distance along suture, broadest at external margin, and a wider band between preceding band and apex, narrowly divided at suture; ventral surfaces densely clothed with yellow pubescence except on anterior portion of mesosternum, mesepimeron, central portion of metasternum, and basal margins and centers of abdominal sternites; antennæ ochraceous brown, scape and apices of following segments duller; legs dark reddish brown; swollen portions of femora, apices of tibiæ, and tarsal segments nearly black.

Head deeper than wide, plane in front, depressed at vertex, largely granulate-punctate; frons much higher than wide, narrowed above, feebly carinate medially; vertex feebly concave, as broad as distance between inferior eye lobes, the latter wider than deep. Antennæ reaching to end of first third of elytra; scape one and one-fourth as long as third segment, third to tenth segments gradually shorter. Prothorax a little longer than broad, swollen before middle. Scutellum short, rounded. Elytra twice as long as head and prothorax together, narrowed posteriorly, subobliquely rounded-truncate apically. Posterior femora extending considerably beyond elytral apices; first hind tarsal segment twice as long as following two segments combined.

Length, 11 millimeters; breadth, 3.2.

Holotype, female, No. 53473, United States National Museum, Khun Tan Mountains, altitude 3000 feet, northern Siam, May 1933, Hugh M. Smith.

Differs from *Chlorophorus annularis* (Fabr.) in being much stouter, more narrowed posteriorly, with the antennæ shorter and thicker and the head more plane in front. This species seems to approach *Xylotrechus* rather closely in several of its characteristics. It differs from *X. subdepressus* (Chevr.) in having the frons more constricted near the eyes, almost entirely pubescent, and indistinctly carinated, the prothorax with three round, black spots, and the elytra with a pair of ringlike spots and two fasciæ.

This species is named in honor of Dr. Hugh M. Smith, formerly of Bangkok, where he was in charge of the Bureau of Fisheries of the Government of Siam.

Genus RHAPHUMA Pascoe, 1858

13. RHAPHUMA SULPHUREA Gressitt sp. nov. Plate 1, fig. 2.

Body black, densely clothed beneath with pale sulphur-yellow pubescence, and above with sulphur-green pubescence, marked with black as follows: prothorax with a pair of discal ( )-shaped marks, each connected with a short transverse bar at anterior end and a short, longitudinal stripe at each side, elytra with external margin, a narrow humeral stripe extending to end of basal third, a slightly sinuous discal stripe from near base to middle, followed by a shorter, suboblique stripe, and lastly a transverse band at beginning of apical quarter, not quite touching suture and external margins; antennæ ochraceous, thinly clothed with whitish hairs, apical segments slightly dull internally; legs ochraceous, swollen portions of femora blackish brown clothed with sulphur-green hairs. Inner sides of basal antennal segments, prothorax, bases of elytra, and ventral surfaces with very fine, suberect hairs.

Head about as broad as deep; frons squarish, a small nude area in middle; vertex grooved and slightly concave between antennal supports; occiput granulate behind; eyes deeply emarginate, lower lobes egg-shaped. Antennæ as long as body; scape arched, feebly thickened apically, three-fourths as long as third segment; fourth segment a little shorter than fifth, the latter not quite as long as third. Prothorax subcylindrical, weakly rounded laterally, a little longer than broad, granulose on surface. Scutellum short, rounded. Elytra parallel; apices narrowed and obliquely truncate; surfaces finely rippled-punctate. Legs slender; posterior femora exceeding elytral apices by one-fourth their length; first hind tarsal segment as long as following segments united; tarsal claws fully one-half as long as segments bearing them.

Length, 11 millimeters; breadth, 3.

Holotype, male, No. 53472, United States National Museum, Khun Tan Mountains, altitude 4,000 feet, northern Siam, May 1933, Hugh M. Smith.

Differs from *Rhaphuma quadricolor* Cast. and Gory in being less slender, with the vertex broader, the eyes smaller, the prothorax shorter, and the body less densely clothed with pubescence, besides being differently marked.

Genus DEMONAX Thomson, 1861

14. DEMONAX ELONGATULUS (Castelnau and Gory).

Clytus elongatulus CASTELNAU and GORY, Monogr. Genre *Clytus* (1841) 97, pl. 18, fig. 116.

Demonax elongatulus CHEVROLAT, Mem. Soc. Sci. Liege 18 (1869) 271; reprint, p. 19.

Two specimens were collected at Sarakam, eastern Siam, March 21, 1929, by Dr. Hugh M. Smith. One specimen is in the United States National Museum and one in my collection.

LAMIINÆ

MONOCHAMINI

Genus ARCTOLAMIA Gestro, 1888

15. ARCTOLAMIA FASCIATA Gestro.

Arctolamia fasciata GESTRO, Ann. Mus. Civ. Genova (2) 4 (1888) 222, fig., Tenasserim.

Three specimens were collected: one at Kanburi and two at Dai Nangka, northern Siam, November 8, 1930, by Dr. Hugh M. Smith. Two are in the United States National Museum and one is in my collection. New to Thai.

Genus PARALEPRODERA Breuning, 1935

16. PARALEPRODERA INSIDIOSA (Gahan).

Leprodera insidiosa GAHAN, Ann. & Mag. Nat. Hist. (6) 2 (1888) 391.

Specimens were collected at Trong, lower Siam, by W. L. Abbott.

Genus EPEPEOTES Pascoe, 1866

17. EPEPEOTES LATERALIS (Guerin).

Monochamus lateralis GUERIN, Dict. Class. d'Hist. Nat. 17 (1831) pl. 68, fig. 6.

Epepeotes meridianus PASCOE, Trans. Ent. Soc. London (3) 3 (1866) 302.

Two specimens: one from Khow Sai Dow, the other from Trong. New to Thai.

Genus PELARGODERUS Serville, 1835

18. PELARGODERUS sp.

Three examples of a form closely resembling *P. bipunctatus* (Dalm.) were taken at Trong by W. L. Abbott.

Genus PERIHAMMUS Aurivillius, 1924

19. PERIHAMMUS LUTEOFASCIATUS Gressitt sp. nov. Plate 1, fig. 8.

Female.—Black; elytra crossed by two slightly undulating transverse bands of pale-yellow pubescence, each a little more

than a millimeter wide, the first placed after basal fifth, the second before apical quarter; third to tenth antennal segments each with basal quarter or basal third clothed with tawny-gray hairs; black portions of body largely clothed with a thin layer of silvery-gray pubescence.

Head deeper than wide, minutely punctulate except for a few sparse, shallow punctures on antennal tubercles; frons slightly swollen, higher than wide, a little broader above than below; antennal tubercles fairly prominent, diverging at an angle of about 100°, occiput even, feebly grooved; eyes deeply emarginate, inferior lobes deeper than wide, reaching three-fourths distance to bases of mandibles. Antennæ one and one-half as long as body; scape very slightly and gradually thickened apically, nearly as long as third segment, subequal to fourth; fourth to tenth segments gradually diminishing in length. Prothorax broader than long, armed at middle of each side with a broad-based and moderately acute tubercle; disc feebly swollen on each side of midline before center and behind middle, punctured in a sparse and irregular manner. Scutellum short, rounded-triangular. Elytra subparallel, subrounded apically, distinctly punctured in irregular rows basally, the punctures disappearing before apices. First hind tarsal segment shorter than following two segments united.

Length, 13.3 millimeters, breadth, 4.7.

Holotype, female, No. 53471, United States National Museum, Khun Tan Mountains, altitude 4,000 feet, northern Siam, May 1933, Dr. Hugh M. Smith, collector.

Differs from *Perihammus bifasciatus* Aurivillius in being slightly broader, in being black with two distinct, subtransverse, yellowish bands, and in having the antennæ thicker, the prothorax more strongly tuberculate laterally, and the elytra more heavily punctured basally and rounded apically.

MESOSINI

Genus CACIA Newman, 1842

20. CACIA sp.

A specimen probably representing a new species was taken in the Khun Tan Mountains, northern Siam, by Dr. Hugh M. Smith.

Genus COPTOPS Serville, 1835

21. COPTOPS LICHENEA Pascoe.

Coptops lichenea PASCOE, Trans. Ent. Soc. London (3) 3 (1865) 118, Malacca.

A specimen was collected at Trong, lower Siam, by W. L. Abbott. New to Thai.

ANCYLONOTINI

Genus PALIMNA Pascoe, 1862

22. PALIMNA ANNULATA TESSELLATA (Pascoe).

Golsinda tessellata PASCOE, Trans. Ent. Soc. London (2) 4 (1857) 49, Borneo.

Palimna tessellata PASCOE, Trans. Ent. Soc. London (3) 3 (1865) 135, pl. 6, fig. 2.

Palimna annulata var. *tessellata* AURIVILLIUS, Col. Cat. 73 (1922) 152.

Specimens were collected at Trong, lower Siam, by W. L. Abbott. New to Thai.

23. PALIMNA MIMICA Fairmaire.

Palimna mimica FAIRMAIRE, Ann. Soc. Ent. France 67 (1898) 399, Butang.

A specimen was collected at Bangkok by Dr. Hugh M. Smith and is in the United States National Museum. New to Thai.

DORCASCHEMATINI

Genus OLENOCAMPTUS Chevrolat, 1835

24. OLENOCAMPTUS SIAMENSIS Breuning.

Olenocamptus siamensis BREUNING, Festschr. E. Strand 1 (1936) 319, Siam.

One specimen probably referable to this species was taken at Bangkok by Dr. Hugh M. Smith and is in the United States National Museum.

NIPHONINI

Genus PTEROLOPHIA Newman, 1842

25. PTEROLOPHIA spp.

Unique specimens of two species were taken at Trong by W. L. Abbott.

Genus DAXATA Pascoe, 1864

26. DAXATA USTULATA Pascoe. Plate 1, fig. 4.

Daxata ustulata PASCOE, Proc. Zool. Soc. London (1866) 230, p. 27, fig. 4, Penang.

One specimen was collected at Trong, lower Siam, by W. L. Abbott, and is in the United States National Museum. New to Thai.

Genus PARAPHEMONE Gressitt, 1935

27. PARAPHEMONE MULTIMACULATA Gressitt.

Paraphemone multimaculata GRESSITT, Philippine Journ. Sci. 58 (1935) 279, Siam.

Known only from the type specimen in the United States National Museum, collected at Trong, lower Siam, by W. L. Abbot.

Genus STHENIAS Castelnau, 1840

28. STHENIAS FRANCISCANUS Thomson.

Sthenias franciscanus THOMSON, Syst. Ceramb. (1865) 550.

One specimen probably referable to this species was taken at Trong, lower Siam, by W. L. Abbott. New to Thai.

HIPPOPSINI

Genus POTHYNE Thomson, 1864

29. POTHYNE VARIEGATA Thomson.

Pothyne variegata THOMSON, Syst. Ceramb. (1864) 97; LACONDAIRE, Gen. Col. 9 (1872) 694; GAHAN, Ann. Mus. Civ. Genova 34 (1894) 78.

One specimen was collected at Bangkok by Dr. Hugh M. Smith, and is in the United States National Museum.

LIST OF CERAMBYCIDÆ OF THAI

PRIONINÆ

PRIONINI

Dorysthenes rostratus (Fabricius), Ent. Syst. 1, 2 (1792) 243.
Baladeva walkeri Waterhouse, Trans. Ent. Soc. London 2 (1840) 226, pl. 21, fig. 1.
Paraphrus granulosus (Thomson), Essai Classif. Ceramb. (1861) 329.

MACROTOMINI

Remphan hopei Waterhouse, Trans. Ent. Soc. London 1 (1836) 67, pl. 8, fig. 1.

MEGOPIDINI

Megopis (*Ægolipton*) *marginalis* (Fabricius), Syst. Ent. 2 (1775) 169.

PHILINI

Philus costatus Gahan, Ann. & Mag. Nat. Hist. (6) 9 (1893) 254.

DISTENIINÆ

DISTENIINI

Distenia fulvipennis Gressitt, Philippine Journ. Sci. 58 (1935) 267.

LEPTURINÆ

LEPTURINI

Ocalemia aureoviridis Gressitt sp. nov.

CERAMBYCINÆ

HESPEROPHANINI

Stromatium longicorne (Newman), Entomologist 1 (1842) 246.
Gnatholea eburifera Thomson, Essai Classif. Ceramb. (1861) 375.
Zoodes compressus (Fabricius), Mantissa Ins. 1 (1787) 153.

CEMINI

Tetraommatus insignis Gahan, Ann. Mus. Civ. Genova 34 (1894) 8, pl. 1, fig. 1.
Xystrocera globosa (Olivier), Entomologie (4) 67 (1795) 27, pl. 12, fig. 81.

CERAMBYCINI

Æolesthes holosericea (Fabricius), Mantissa Ins. 1 (1787) 135.
Æolesthes induta (Newman), Entomologist 1 (1842) 245.
Neocerambyx paris (Wiedemann), Germ. Mag. Ent. 4 (1821) 167.
Plocæderus obesus Gahan, Ann. & Mag. Nat. Hist. (6) 5 (1890) 51.
Nadezhdiella cantori (Hope), Trans. Ent. Soc. London 4 (1845) 11.
[= *Cerambyx lucasi* Brongniart, Nouv. Arch. Mus. Paris (3) 3 (1892) 238, pl. 10, fig. 1.]
Diorthrus cinereus (Fabricius), Ent. Syst. 2 (1792) 264.
Dialeges undulatus Gahan, Ann. & Mag. Nat. Hist. (6) 7 (1891) 23.
Rhytidodera integra Kolbe, Archiv Naturg. 3 1 (1886) 237.
Rhytidodera siamica Nonfried, Berliner Ent. Zeit. 36 (1892) 378.
Xoanodera pascoei Brongniart, Nouv. Arch. Mus. Paris (3) 3 (1892) 239.
Zegriades fulvipennis Nonfried, Berliner Ent. Zeit. 40 (1895) 309.
Zegriades siamensis Nonfried, Berliner Ent. Zeit. 40 (1895) 308.

CALLIDIOPSINI

Ceresium geniculatum White, Cat. Col. Brit. Mus. 8 (1855) 245.
Ceresium leucosticticum White, Cat. Col. Brit. Mus. 8 (1855) 245, pl. 6, fig. 1.
Gelonœtha hirta (Fairmaire), Rev. et Mag. de Zool. (1850) 60.

PHORACANTHINI

Nyphasia pascoei Lacordaire, Gen. Col. 8 (1869) 309.

COMPSOCERINI

Rosalia lameerei Brongniart, Bull. Soc. Ent. France (1890) cxxi.
Acrocyrtidus fasciatus Jordan, Nov. Zool. 1 (1894) 500, pl. 13, fig. 10.

CALLICHROMINI

Pachyteria bouvieri Ritsema, Bull. Mus. Paris 2 (1896) 330.
Pachyteria fasciata (Fabricius), Syst. Ent. (1775) 168.
Pachyteria virescens Pascoe, Proc. Zool. Soc. London (1866) 519, pl. 43, fig. 2.
Chelidonium binotatum Brongniart, Nouv. Arch. Mus. Paris (3) 3 (1892) 245, pl. 10, fig. 9.
Polyzonus bizonatus White, Cat. Col. Brit. Mus. 7 (1853) 171.
Polyzonus prasinus (White), Cat. Col. Brit. Mus. 7 (1853) 170.
Anubis bipustulatus Thomson, Syst. Ceramb. (1865) 569.
Anubis bipustulatus ab.
quadripustulatus Plavilstshikov, Ent. Blätter 23 (1927) 108.
tripustulatus Plavilstshikov, Ent. Blätter 23 (1927) 108.
Anubis fimbriatus Bates, Cist. Ent. 2 (1879) 412.
Anubis inermis (White), Cat. Col. Brit. Mus. 7 (1853) 171.

PYRESTINI

Pachylocerus sulcatus Brongniart, Nouv. Archiv Mus. Paris (3) 3 (1891) 240, pl. 10, fig. 4.

CLYTINI

Xylotrechus buqueti (Castelnan and Gory), Hist. Nat. Icon. Ins. Col. (Monogr. Gen. *Clytus*) (1841) 86, pl. 16, fig. 99.
Xylotrechus quadripes Chevrolat, Mem. Soc. R. Sci. Liege 18 (1863) 315.
Perissus laetus Lameere, Ann. Soc. Ent. France 62 (1893) 283.
Perissus mutabilis Gahan, Ann. Mus. Civ. Genova 34 (1894) 23.
Clytosaurus siamensis Jordan, Nov. Zool. 1 (1894) 497, pl. 13, fig. 9.
Chlorophorus annularis (Fabricius), Mantissa Ins. 1 (1787) 156.
Chlorophorus rubricollis (Castelnau and Gory), Monogr. Gen. *Clytus* (1841) 88, pl. 16, fig. 102.
Chlorophorus smithi Gressitt sp. nov.
Rhaphuma sulphurea Gressitt sp. nov.
Demonax elongatulus (Castelnau and Gory), Monogr. Gen. *Clytus* (1841) 97, pl. 18, fig. 116.

CLEOMENINI

Nida flavovittata Pascoe, Ann. & Mag. Nat. Hist. (3) 19 (1867) 312.

STENASPINI

Pavieia superba Brongniart, Bull. Soc. Ent. France (1890) 185.
Purpuricenus malaccensis Lacordaire, Gen. Col. 9 (1869) 176, note 2.
[= *P. fasciatus* Brongn., Nov. Arch. Mus. Paris (3) 3 (1892) 241, pl. 10, fig. 5.]

LAMIINÆ

MONOCHAMINI

Arctolamia fasciata Gestro, Ann. Mus. Civ. Genova (2) 6 (1888) 129.
Epicedia triangularis Thomson, Syst. Ceramb. (1865) 554.
Paraleprodera cordifera (Thomson), Syst. Ceramb. (1865) 554.
Paraleprodera insidiosa Gahan, Ann. & Mag. Nat. Hist. (6) 2 (1888) 391.
Paraleprodera lecta Gahan, Ann. & Mag. Nat. Hist. (6) 2 (1888) 389.
Macrochenus guerinii White, Ann. & Mag. Nat. Hist. (3) 2 (1858) 274.
Epepeotes luscus (Fabricius), Mantissa Ins. 1 (1787) 139.
Epepeotes lateralis (Guerin), Dict. Class. d'Hist. Nat. 17 (1831) pl. 68, fig. 6.
Monochamus bimaculatus Gahan, Ann. & Mag. Nat. Hist. (6) 2 (1888) 260.
Pelargoderus sp.
Gerania bosci (Fabricius), Syst. Eleuth. 2 (1801) 323.
Melanauster zonator Thomson, Revue Zool. (3) 7 (1878) 50.
Pseudocyriocrates strandi Breuning, Fol. zool.-hydrobiol. 8 (1935) 64.
Aristobia voeti Thomson, Revue Zool. (3) 6 (1878) 51.
[= *A. angustifrons* Gahan, Ann. & Mag. Nat. Hist. (6) 1 (1888) 276.]
Cremnosterna carissima (Pascoe), Trans. Ent. Soc. London (2) 4 (1857) 104.
Perihammus luteofasciatus Gressitt sp. nov.
Blepephæus marshalli Breuning, Fol. zool.-hydrobiol. 8 (1935) 69.
Blepephæus pardalinus Breuning, Fol. zool.-hydrobiol. 8 (1935) 68.
Blepephæus succinctor (Chevrolat), Revue Zool. (2) 4 (1852) 417.

Cratotragus cinabarrinus Lacordaire, Gen. Col. 9 (1869) 332, note 2.
Cereopsius siamensis Breuning, Festschr. E. Strand 1 (1936) 299.
Haplothrix blairi Breuning, Fol. zool.-hydrobiol. 8 (1935) 67.
Haplothrix simplex Gahan, Ann. & Mag. Nat. Hist. (6) 1 (1888) 278.

AGNIINI

Pharsalia pulchra Gahan, Ann. & Mag. Nat. Hist. (6) 1 (1888) 280.
Cycos subgeminatus (Thomson), Archives Ent. 1 (1857) 294.

BATOCERINI

Batocera hector helena Thomson, Syst. Ceramb. (1865) 552.
Batocera munitor ferruginea Thomson, Archives Ent. 1 (1858) 456.
Batocera rubus punctatella Kriesche, Archiv Naturg. 80 A 11 (1915) 135, fig. 15.

GNOMINI

Imantocera olivieri Thomson, Syst. Ceramb. (1865) 555.

MESOSINI

Golsinda basicornis Gahan, Ann. Mus. Civ. Genova 34 (1894) 48.
Cacia sp.
Coptops annulipes Gahan, Ann. Mus. Civ. Genova 34 (1894) 54.
Coptops lichenea Pascoe, Trans. Ent. London (3) 3 (1865) 118.
Coptops pascoei Gahan, Ann. Mus. Civ. Genova 34 (1895) 55.
Mutatocoptops similis Breuning, Folia zool.-hydrobiol. 8 (1935) 263.
Pseudochœromorpha siamensis Breuning, Festsch. E. Strand 1 (1936) 310.
Saimia siamensis Breuning, Festchr. E. Strand 4 (1938) 200.
Therippia (*Paratherippia*) *mediofasciata* Breuning, Folia zool.-hydrobiol. 8 (1935) 274.

ANCYLONOTINI

Palimna annulata tessellata Pascoe, Trans. Ent. Soc. London (2) 4 (1857) 49.
Palimna mimica Fairmaire, Ann. Soc. Ent. France 67 (1898) 399.

DORCASCHEMATINI

Olenocamptus bilobus (Fabricius), Syst. Eleuth. 2 (1801) 324.
Olenocamptus diversemaculatus Breuning, Festschr. E. Strand 4 (1938) 225.
Olenocamptus siamensis Breuning, Festschr. E. Strand 1 (1936) 319.

ECYROSCHEMINI

Apatelarthron heteroclitum Thomson, Syst. Ceramb. (1864) 89.

NIPHONINI

Niphona scopulifera (Thomson), Syst. Ceramb. (1864) 54.
Camptocnema lateralis (White), Ann. & Mag. Nat. Hist. (3) 2 (1858) 267.
Pterolophia canescens Breuning, Festschr. E. Strand 5 (1939) 193.
Pterolophia siamensis Breuning, Festschr. E. Strand 4 (1938) 278.
Pterolophia transversefasciata Breuning, Festschr. E. Strand 4 (1938) 252.
Pterolophia virgulata Breuning, Festschr. E. Strand 5 (1939) 193.
Daxata ustulata Pascoe, Proc. Zool. Soc. London (1866) 230, pl. 27. fig. 4.
Paraphemone multimaculata Gressitt, Philip. Journ. Sci. 58 (1935) 279.

Sthenias franciscanus Thomson, Syst. Ceramb. (1865) 550.
Dystasia siamensis Breuning, Festschr. E. Strand 4 (1938) 383.
Egesina siamensis Breuning, Festschr. E. Strand 4 (1938) 386.

NEDININI

Nedine longipes Thomson, Syst. Ceramb. (1864) 27.

HIPPOPSINI

Pothyne variegata Thomson, Syst. Ceramb. (1864) 97.
Pothyne griseolineata Breuning, Fol. Zool.-hydrobiol. 10 (1940) 188.
Pothyne ochracea Breuning, Fol. Zool.-hydrobiol. 40 (1940) 188.

SAPERDINI

Serixia sedata Pascoe, Journ. Ent. 1 (1862) 354.

GLENEINI

Glenea (*Stiroglenea*) *cancellata* Thomson, Syst. Ceramb. (1865) 565.
Glenea diana Thomson, Syst. Ceramb. (1865) 561.
Glenea siamensis Gahan, Ann. & Mag. Nat. Hist. (6) 19 (1897) 479.
Heteroglenea nigromaculata (Thomson), Syst. Ceramb. (1865) 566.
Stibara rufina Pascoe, Trans. Ent. Soc. London (2) 4 (1858) 259.

PHYTOECIINI

Nupserha variabilis Gahan, Ann. Mus. Civ. Genova 34 (1894) 92.

TETRAOPINI

Cleonaria bicolor Thomson, Syst. Ceramb. (1864) 119.
Anastathes biplagiata Gahan, Trans. Ent. Soc. London (1901) 61, pl. 4, fig. 9.
Astathes dimidiata (Gory) in Guerin, Icon. Regne Anim.-Ins. (1832) pl. 45, fig. 3; (1844) 244.
Astathes nitens (Fabricius), Syst. Eleuth. 2 (1801) 279.
[= *A. fabricii* Thomson, Syst. Ceramb. (1865) 558].

CORRECTIONS TO "THE LONGICORN BEETLES OF HAINAN ISLAND" COLEOPTERA: CERAMBYCIDÆ

By J. Linsley Gressitt

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Page.	Line.	As printed.	Correct form.
2	9	Van Dyke	van Dyke
9	34	*Microstola*	*Microestola*
20	7	MEZOPIDINI	MEGOPIDINI
81	15 (insert following):		

A single male (Lingnan Nat. Hist. Mus.) was taken at Tai-ping-ts'uen, near Loi Mother Mountain, April 25, 1935, by F. K. To.

New to Hainan.

104	7 (from bottom)	Faan-na	Faan-a
118	5	Nos. 53456 and 53459	No. 53459
152	5 (from bottom)	Nos. 53457 and 53475	No. 53457
158	19	PRESATES	PHESATES
170	19	Trans. Soc. Lond.	Trans. Ent. Soc. Lond.
183	2 (from bottom)		
190	8	*Oligospis*	*Oligopsis*
	10–11 Delete last phrase of paragraph: one paratype .....Museum.	author, No. 53450	author, 1 No. 53450
211	18	scape	scape
228	7	ꝑ	p′
	8	ꞇ	t′
	7 (from bottom) — Reverse order of Chinese characters.		
229	8 (from bottom)	Leng-moon †	Leng-moon *
230	8 and 12 (from bottom)—Chinese characters shuffled.		
230	2 (from bottom), and p. 231, lines 1 and 4—Characters shuffled.		
233	23 (from bottom)	pls. 1–33.	pls. 1–3.
	14 (from bottom)	pt. 1 9 (1869)	9, pt. 1 (1869)
	12 (from bottom)	pt. 2 1 (1872)	9, pt. 2 (1872)

ILLUSTRATION

PLATE 1

FIG. 1. *Chlorophorus smithi* Gressitt sp. nov.; holotype, × 4.5.
2. *Rhaphuma sulphurea* Gressitt sp. nov.; holotype, × 4.9.
3. *Perihammus luteofasciatus* Gressitt sp. nov.; holotype, × 4.5.
4. *Daxata ustulata* Pascoe; Trong, Lower Siam, × 2.7.

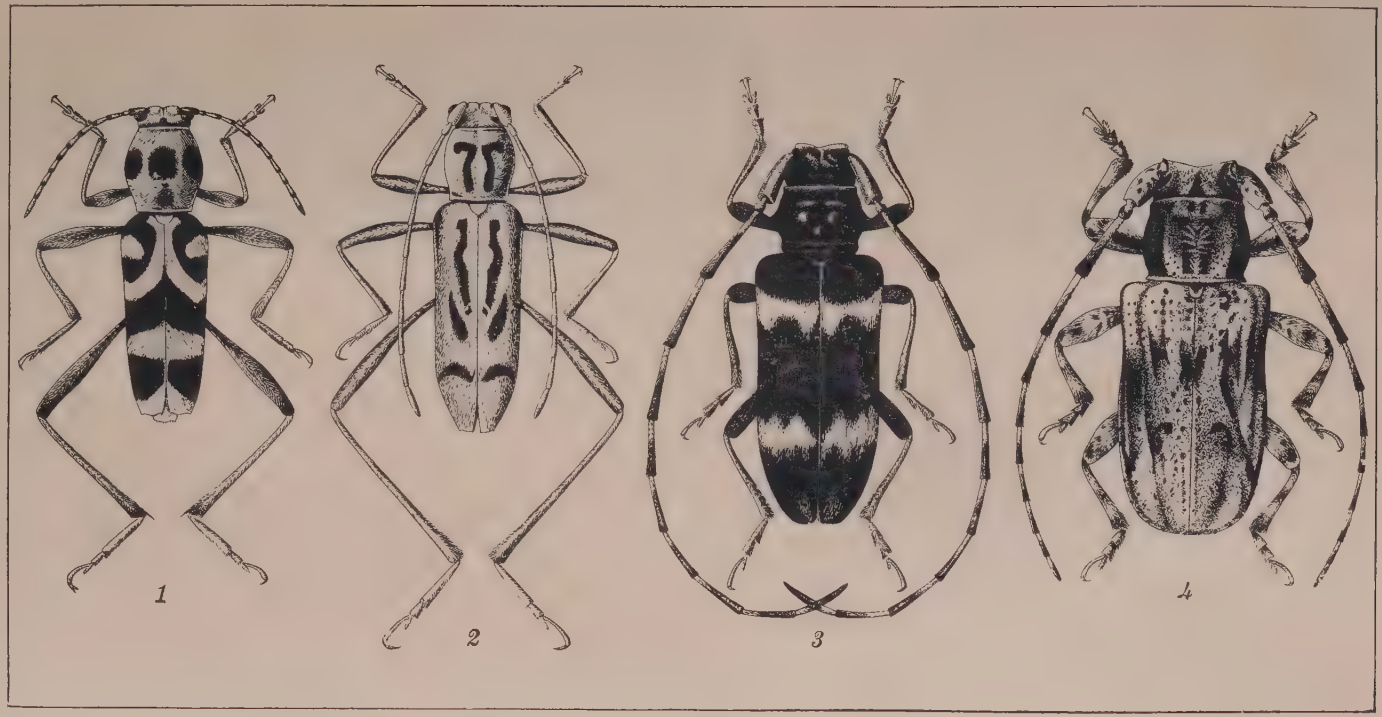

PLATE 1.

IFUGAO SOMATOLOGY

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and

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While on an anthropological field trip in 1937,[1] R. F. Barton gathered somatological data on 124 Ifugaos, 109 men and 15 women. The women were all born in the vicinity of Balitang, the men, 56 in Balitang, 21 in Kiangan, 14 in Hapao, 9 in Benauwe, and 9 in Amduntug. In working up the data the measurements of 2 Kiangan men were not included because one was of half Ilokano blood and the other of one quarter Spanish blood (stature, 181 cm).

The distribution of the subjects by age groups was as follows:[2]

Table 1.—*Distribution of the 122 Ifugaos included in this study by age groups.*

Age in years.	Males.	Females.
18–20	8	3
21–25	23	4
26–30	18	
31–35	10	
36–40	13	6
41–45	10	1
46–50	11	
51–55	20	
56–60	1	
66–70	2	
No notation of age		
	9	1
	107	15

[1] Assisted by grants-in-aid from the Social Science Research Council, New York, and the National Research Council, Washington.

[2] Subjects' ages had to be estimated except in the case of a number of the younger Ifugaos.

Seventeen hair samples were obtained from 11 males, 3 females, and 3 without notation of sex.

The measurements were made with the instruments of Rudolph Martin. Eye color was determined by Martin's scale (old); skin color by Luschan's shade scale, and hair color by E. Fischer's scale (old). All data, including nonmensurable, were recorded on the Harvard University card of anthropometry.

If the nasion could not be palpated, it was assumed to be well above the lowest point of the nasion depression, for observations on living subjects and on Ifugao and other Indonesian skulls showed that, as a rule, the frontal bone strongly overhangs the nasal bones, which typically turn abruptly forward to meet it. The nasal width recorded was the greatest width of the alæ when the features were in repose.

The span recorded was the utmost reach that the subject could make.

The statistical computations were made by A. G. Yasnunskaya of the laboratory of the Institute of Anthropology, Moscow State University, and by E. G. Zhirov of the Anthropological Department of the Institute of Ethnography of the All-Union Academy of Science, USSR. Investigation of the hair specimens was carried out by Prof. J. J. Roginsky, one of the authors, and by P. I. Zenkovich, scientific worker of the Institute of Anthropology.

THE PRINCIPAL NONMENSURABLE CHARACTERS

Form and color of the hair.—The Ifugaos use hair in sorcery; consequently a good deal of opposition was encountered in the taking of hair specimens. Of the 17 specimens obtained, 12, or about 75 per cent, were characterized as either "extremely coarse" or "quite coarse"; 3 as "coarse"; and 2 as "half coarse." Of the "half coarse" specimens, 1 was that of a 20-year-old woman; the age and sex of the other donor was not recorded. Of the 3 "coarse" specimens, 2 were from boys 13 and 15 years old and 1 was from a 40-year-old man. All specimens were straight and, excluding those from women, children, and instances in which sex was not recorded, the overwhelming majority of the specimens might be characterized as exceedingly coarse. Waviness of the hair occurs, but unfortunately this character was not recorded. The color was always black—No. 27 by the E. Fischer scale.

Ifugaos pluck out their beard with bamboo or metallic tweezers—a painful process. The beard appears gradually with advancing maturity and is in nearly all cases sparse, never thick.

The tertiary hair covering is always weakly developed.

Skin color was determined at the midpoint of the inner surface of the upper arm; if the point was not clean, it was scrubbed and allowed to dry before the observation was taken. The data are:

TABLE 2.—*Skin color in the 122 Ifugaos included in this study.*

Birthplace.	Number.	Light brown.			Red brown.			Medium brown.		
		15	17	18	13	14	16	22	23	24
Balitang	56	2	21	20			1	7	3	2
Do	15		7	3	1	1	3			
All other regions	51	6	31	8			3		3	
	122	8	59	31	1	1	7	7	6	2

Thus 80.3 per cent are light brown, 7.4 per cent reddish brown, and 12.3 per cent medium brown. The most frequent skin color is No. 17 (48.4 per cent). Casual observation gives the impression that the Balitang people are a little darker than Ifugaos of other regions, and that the women there are darker than the men. While not conclusive, the recorded data appear to support this observation.

Eye color.—115 notations of eye color show: black (No. 1, Martin's scale) 4.2 per cent; dark brown (No. 2) 45.8 per cent; (No. 3) 43.8 per cent; light brown (No. 4) 6.2 per cent. Mixed eyes occurred in three cases.

External folds were absent in 55.8 per cent of the cases, weakly developed in 31.6 per cent, and moderate in 12.6 per cent. The medial fold was absent in 79.1 per cent of the cases, and weakly developed in 20.9 per cent. According to Barton's notations, the inner, or "Mongolian," fold was absent in 80.6 per cent of the cases, weakly developed in 16.1 per cent, and moderate in 4.3 per cent. However, Barton's understanding of the anatomy of this fold erred in that he considered it to be such a fold as must necessarily arise beneath the inner extremity of the lower lid. Determination by Roginsky from photographs of 62 of the subjects showed, however, not greatly different results, namely, 15 cases of presence of the fold, or

24.2 per cent. The error in Barton's understanding of the epicanthus appears not to have greatly affected his observations, for the discrepancy with the determination made from photographs may well be due to the disproportionately large number of female subjects photographed (10), the fold being present in 4 of these. It is generally observed that the epicanthus is more frequent among men than among women.

In correspondence with the weak development of the epicanthus is the generally straight and horizontal direction of the eye slit (in 73.9 per cent of the cases). A slight slant was found in 26.6 per cent of the cases and a moderate slant in 8.2 per cent. The eye slit is never round as with Negritos.

The nose.—The following data give a general characterization of the nose. The depression of the nasion was extremely great in 12.7 per cent of the cases, very great in 61.2 per cent, moderate in 16.7 per cent, and small in 9.4 per cent. There was no instance of absence of depression. The root height was quite small in 18.4 per cent of the cases, small in 36.9 per cent, medium in 38.8 per cent, and fairly high in 5.9 per cent. The root width was very small in 1 per cent of the cases, small in 20.4 per cent, medium in 36.9 per cent, great in 32 per cent, and very great in 9.7 per cent. The height of the bridge was small in 57.3 per cent of the cases, medium in 39.8 per cent, and high in 2.9 per cent.

The profile of the bridge was concave in 41.5 per cent of the cases, straight in 57.3 per cent, and convex in 1 per cent.

Alveolar prognathism was absent in 95 per cent of the cases, weakly developed in 3 per cent, moderate in 3 per cent, and strong in 1 per cent.

Chin prominence was weak in 56.4 per cent, moderate in 41.5 per cent, and strong in 2.1 per cent of the cases. The chin was of medial type in 90.7 per cent and bilateral in 9.3 per cent of the cases.

The forehead projected forward in 1 per cent of the cases, was without slope in 23.2 per cent, slanted weakly in 65.7 per cent, and slanted moderately in 10.1 per cent.

The teeth were fully erupted in 78.6 per cent, incompletely erupted in 21.4 per cent of the cases.

Occlusion was normal in 90 per cent of 110 observations, taking as the criterion the orthodontists's "key to occlusion," namely, the interdigitation of the mesiobuccal cusp of the upper first molar in the buccal groove of the lower first molar.

Of the 11 abnormal occlusions (1 case being of somewhat uncertain diagnosis owing to loss of some of the key teeth) 10 were cases of distal occlusion of the mandible, and 1 a case of mesial occlusion. Four of the 10, plus the case of uncertain diagnosis, were found in Hapao, where only 14 subjects were measured. This high percentage, no doubt, is partly a freak of chance, but it is not entirely so, for, to the eye of one trained to observe such things, there is apparent an unmistakably high percentage of distal occlusion in the region. It seems that even the Ifugaos recognize this abnormality of occlusion as a trait of Hapao, for an informant, in relating how he would distinguish the home regions of Ifugao strangers, enumerated among other things projecting teeth as characteristic of the Hapao people. Not all cases, of course, of projecting teeth are distal occlusions, but many are.

No loss of teeth was observed in 67.3 per cent of the cases; loss of 1 to 4 teeth in 14.3 per cent, of 5 to 8 teeth in 9.2 per cent, of 9 to 16 teeth in 5.1 per cent, of 17 or more teeth in 4.1 per cent, there being, in the last category, 2 edentulous cases.

Sixty observations with respect to crowding showed crowding absent in 61.7 per cent of the cases, slight in 28.2 per cent, and considerable in 10.1 per cent.

There was visible caries in 17.7 per cent of the cases.

Wear of the teeth was absent in only 6.6 per cent of the cases. It is always due to betel chewing, especially to the chewing of young areca nuts husk and all, for the husk contains a high percentage of fine, sharp abrasive.

Shovel incisors are characteristic, as is seen from the following data, based on 117 observations:

TABLE 3.—*Incidence of Mongolian fossa.*

Mongolian fossa.	Per cent
Definitely absent	23.5
Probably present, but not pronounced	20.1
Moderately marked	26.1
Very marked	30.3

Thus the Mongolian fossa occurs about three times as frequently as the Mongoloid fold, and the frequencies are those that would result if a population in which each character was universal were crossed with one of equal numbers in which neither character was present, provided the tooth fossa were

a simple dominant and the epicanthus a simple recessive. It is greatly to be doubted that the case is anything of the kind. Indeed, Hauschild, on the basis of very limited but seemingly irreproachable evidence, concludes (2, p. 71) that the Mongoloid fold is a simple dominant. Redenwalt, with much more extensive but less clear-cut evidence, draws no conclusion on the point. (19, p. 245)

All subjects except for a very few who had been pupils in the Protestant Academy in Kiangan were betel chewers. Betel chewing always entails more or less heavy deposits of calculus and the calculus causes more or less severe gingivitis.

Pyorrhœa was not diagnosed by means of an explorer for the reason that no facilities were available for sterilization. On the basis of looseness of the teeth, appearance of the gums, and characteristic odor it appeared to be present in 35.9 of the cases. The probability is that it is much more frequent than this percentage would indicate.

MENSURABLE CHARACTERS

The data covering mensurable characters are shown in Tables 4 and 5. Individuals in age group 18 to 20 years averaged a little over a centimeter taller than those of age group 25 to 30, so they were included in the totals.

No important difference in type between regions is reflected in the mensurable data except that those cases from Balitang, Benauwe, and Kiangan have somewhat wider noses than those from Amduntug and Hapao.

GENERAL CHARACTERS OF THE IFUGAO TYPE

The Ifugaos may be characterized as a low-statured, dolichocephalic, orthognathous, platyrrhine group, having black or dark-brown eyes, light-brown skin, very coarse and straight black hair, and weakly developed tertiary hairy covering; the nasion depression is deep, the root of the nose broad or medium in width, the bridge low or medium in height and concave or straight in profile. The epicanthus is present in about 24 per cent of the cases. The chin is weak or moderately prominent, the forehead straight or slightly slanting, and the face short and of medium width. These characterizations hold for females as well as for males.

TABLE 4.—*Summary of measurements.—all males.*

Measurement.	Number.	Minimum.	Maximum.	M ± m.	s
		cm.	*cm.*	*cm.*	*cm.*
Stature	107	140.7	172.2	157.89±0.52	±5.39
Span	58	142.9	176.5	162.88±0.87	±6.65
Biacromial	56	32.3	38.2	36.17±0.19	±1.43
Bi-iliac	57	23.8	29.0	26.72±0.17	±1.26
Sitting height	106	75.0	92.8	84.72±0.30	±3.08
Head length	107	178.0	204.0	191.56±48	±4.95
Head breadth	107	134.0	154.0	144.21±0.44	±4.60
Minimum frontal	99	90.0	113.0	101.26±0.41	±4.04
Bizygomatic	106	126.0	144.0	136.35±0.39	±4.01
Bigonial	104	96.0	125.0	109.31±0.59	±6.02
Total face height	107	104.0	136.0	117.32±0.61	±6.33
Nose height	107	41.0	57.0	49.38±0.35	±3.59
Nose breadth	107	35.0	50.0	41.64±0.26	±2.74
Cephalic index	107	65.7	81.8	75.34±0.28	±2.89
Facial index	106	75.4	103.0	86.03±0.41	±4.69
Nasal index	107	66.7	102.2	85.05±0.76	±7.88

TABLE 5.—*Measurements, Balitang, males.*

Measurement.	Number.	Minimum.	Maximum.	M ± m.	s
		cm.	*cm.*	*cm.*	*cm.*
Stature	56	140.7	172.2	157.48±0.76	±5.70
Sitting height	56	75.0	90.4	84.11±0.43	±3.21
Head length	56	178.0	2040.	191.41±0.70	±5.26
Head breadth	56	134.0	152.0	143.75±0.59	±4.44
Minimum frontal	48	90.0	113.0	101.62±0.66	±4.54
Bizygomatic	55	128.0	144.0	136.29±0.50	±3.74
Bigonial	56	96.0	125.0	108.91±0.86	±6.44
Total face height	56	104.0	134.0	116.71±0.82	±6.17
Nose height	56	41.0	56.0	49.25±0.48	±3.57
Nose breadth	56	370.0	50.0	42.62±0.31	±2.34
Facial index	55	75.4	96.2	85.77±0.64	±4.78
Nasal index	56	69.8	102.2	87.36±0.98	±7.32

TABLE 6.—*Measurements, Balitang, females.*

Measurement.	Number.	Minimum.	Maximum.	Mean.
		cm.	*cm.*	*cm.*
Stature	15	137.0	157.6	146.1
Sitting height	15	73.3	82.8	79.1
Head length	15	176.0	198.0	183.5
Head breadth	15	133.0	151.0	141.1
Minimum frontal	12	90.0	103.0	97.9
Bizygomatic	15	120.0	139.0	128.5
Bigonial	15	96.0	106.0	100.9
Total face height	14	95.0	125.0	109.6
Nose height	15	37.0	52.0	44.4
Nose breadth	15	34.0	43.0	38.3
Cephalic index	15	72.1	79.5	76.9
Facial index	14	68.4	98.4	85.3
Nasal index	15	68.0	102.7	86.8

TABLE 7.—*Measurements, regions of Ifugao besides Balitang, males.*

Measurement.	Region.	Number.	Minimum.	Maximum.	Mean.
			cm.	*cm.*	*cm.*
Stature	Kiangan	19	149.5	171.0	152.2
	Hapao	14	153.6	167.5	159.0
	Benauwe	9	148.8	164.0	156.7
	Amduntug	9	152.3	163.1	157.3
Sitting height	Kiangan	19	81.3	92.8	86.9
	Hapao	14	82.0	88.8	84.8
	Benauwe	9	82.3	87.6	85.3
	Amduntug	8	77.8	86.1	83.6
Head length	Kiangan	19	182.0	200.0	196.8
	Hapao	14	183.0	202.0	191.9
	Benauwe	9	185.0	202.0	192.6
	Amduntug	9	190.0	196.0	192.6
Head breadth	Kiangan	19	134.0	154.0	146.7
	Hapao	14	135.0	152.0	144.6
	Benauwe	9	139.0	146.0	143.2
	Amduntug	9	134.0	146.0	142.2
Minimum frontal	Kiangan	19	92.0	107.0	101.0
	Hapao	14	94.0	110.0	99.6
	Benauwe	9	99.0	104.0	102.1
	Amduntug	9	98.0	106.0	101.7
Bizygomatic	Kiangan	19	126.0	143.0	137.2
	Hapao	14	131.0	143.0	136.5
	Benauwe	9	131.0	140.0	136.0
	Amduntug	9	126.0	141.0	135.0
Bigonial	Kiangan	19	103.0	117.0	111.1
	Hapao	13	101.0	117.0	108.8
	Benauwe	8	102.0	122.0	110.5
	Amduntug	8	102.0	117.0	107.5
Total face height	Kiangan	19	105.0	135.0	116.9
	Hapao	14	111.0	124.0	119.6
	Benauwe	9	114.0	129.0	119.1
	Amduntug	9	108.0	124.0	115.7
Nose height	Kiangan	19	44.0	56.0	49.7
	Hapao	14	42.0	57.0	49.3
	Benauwe	9	44.0	53.0	48.8
	Amduntug	9	35.0	43.0	39.7
Nose breadth	Kiangan	19	37.0	47.0	41.2
	Hapao	14	37.0	45.0	39.4
	Benauwe	9	38.0	47.0	41.9
	Amduntug	9	35.0	43.0	39.7
Cephalic index	Kiangan	19	72.5	81.8	76.9
	Hapao	14	71.3	80.4	75.4
	Benauwe	9	70.3	78.9	74.4
	Amduntug	9	69.1	76.4	73.9
Facial index	Kiangan	19	78.2	94.4	85.1
	Hapao	14	79.0	103.0	87.6
	Benauwe	9	82.0	98.5	87.6
	Amduntug	9	80.0	93.7	85.8
Nasal index	Kiangan	19	72.7	97.8	83.2
	Hapao	14	66.7	95.7	80.5
	Benauwe	9	74.5	100.0	86.4
	Amduntug	9	72.6	91.1	79.1

So far as bodily proportions are concerned, the Ifugaos may be classed as relatively short-legged:

$$\frac{\text{Stature—Sitting height}}{\text{Stature}} \times 100 = 46.22 \text{ for males and } 45.85 \text{ for females.}$$

Comparison with other Ifugao data.—The only other data that have been published are those of Barrows:(1)

10 Benauwe Men

Stature	155.2
Cephalic index	76.9
Nasal index	101.9

So far as concerns stature and cephalic index, these figures are quite near to those given here, but there is a wide discrepancy in the nasal index, which may be attributable to a difference in the technique of measuring this character, or possibly to another factor. From the text accompanying Barrows's measurements it seems likely that he measured "professional" cargadores, and it is not unlikely that he measured them after they had carried burdens for him weighing 50 pounds or so over 30 to 40 kilometers of steep road. Under such conditions, or if the subjects habitually worked as carriers, the nostrils would be considerably distended.

Soon after the American occupation Barrows advanced the hypothesis that there are only two fundamental races in the Philippines, namely, a short-headed, mesorrhine Malayan race, represented by such great lowland nationalities as the Tagalogs, Visayans, Ilokanos, Bicols, Pangasinanes, and others, and an aboriginal Negrito population. This Negrito population, aside from its specific negroid traits, is definitely short-headed. Barrows contended that the long-headed wide-nosed tribes, such as the Ifugao, the Bontok, the Nabaloi, Kankanai, Manobo, and several others of the so-called "pagan" tribes are a remote, "stable" cross between the Malayans and the Negritos. Sullivan attacked this theory on several grounds any one of which would seem to have been sufficient to controvert it. For example, he said that it is hard to see how a cross between two short-headed groups could give a long-headed one.

There can be no doubt that only a few generations ago Negritos roamed the territory now exclusively occupied by the Ifugaos, and there is even a tradition which might be interpreted as implying cases of intermarriage. (16, p. 456) Nevertheless, one never sees an Ifugao who manifests specifically

Negritoid traits, unless platyrrhiny can be admitted as such a trait. Thomson and Buxton have presented a strong case for the view that nasal index, while to some degree inherited and racial, is at the same time greatly dependent on climatic and environmental conditions. Moreover, a calculation made in the laboratory of the Institute of Anthropology, Moscow, of the correlation between cephalic and nasal indices for 78 Philippine groups (excluding Negritos), showed a negative correlation of 0.604 ± 0.072—that is to say, a statistically significant value, the more significant because it was calculated not for individuals but for average arithmetical quantities. Barrows's theory is thus obviously untenable and has found no acceptance.[3]

The authorities are in practical agreement that there are three great racial stocks native in southeastern Asia: Negrito, Pre-Dravidian or Veddoid, and a third, the so-called "Brown" race, Malayan, or Maritime Mongols. The latter is divided into two subraces, one of which has been called "Indonesian," "Old Malay," "proto-Malay," or "Nesiot," and the other "New Malay or "deutero-Malay."

The somatological characters of these types may be summed up as follows:

Negrito.—Negroid affinities; hair kinky and woolly; skin, dark brown, approaching black; eye slit round, open; head brachycephalic; nose platyrrhine, index above 93 (Sullivan); stature shortest of all races, average in the Philippines (according to Sullivan) about 150 cm.

Pre-Dravidian or Veddoid.—Australoid affinities; hair curly; skin various shades of brown; eye slit open and roundish, but less so than the Negroid eye; cephalic index capricious

[3] H. H. Bartlett [Fifth Pacific Science Congress. (2, p. 2851)] prefers to account for certain curly-headed Bataks (brachycephalic, however) on the basis of a Negrito admixture rather than of Veddoid: "In the light of present knowledge" he says (p. 2857) "we are, therefore, not justified in adopting the hypothesis that curly hair came into the population with a mesocephalic "Vedda"-like type, but neither is this hypothesis excluded. We can only say that it is simpler to assume that Negrito admixture is sufficient to account for the segregation of individuals with curly hair, perhaps not only in Sumatra but even in the Malay Peninsula." He also says, in effect, that like does not always give like in the matter of head form—that dolichocephalic children may be born of brachy- and mesocephalic parents. This, however, is quite different from an origin of a dolichocephalic race or breed from the crossing of two brachy- or mesocephalic races.

but predominatingly dolicho- or meso-. Nasal index high, overlapping that of the Negritos; stature short—about 155 cm.

Indonesians.—Mixed affinities but predominatingly Mongoloid; hair usually straight, but sometimes wavy; skin light or medium brown; eye slit narrow, straight or oblique, Mongoloid fold fairly frequent but less so than among the deutero-Malays; dolicho- or mesocephalic; mesorrhine or platyrrhine; stature less than that of the deutero-Malays—average in the Philippines (according to Sullivan(22) about 156 cm.

Deutero- or "New" Malays.—Affinities more Mongoloid than the Indonesian; hair usually straight, but sometimes wavy;[4] skin light or medium brown; eye slit, narrow, with obliqueness and Mongoloid fold more often present than with the Indonesians; definitely brachycephalic; mesorrhine; stature in the Philippines (according to Sullivan), about 160 cm.

The differences between the Indonesian type and the deutero-Malay lie mainly in the respects of frequency of the Mongoloid fold, in cephalic and nasal indices, and in stature.

The pre-Dravidians are generally recognized as the aborigines (along with the Negritos, perhaps) of southeastern Asia and of Australia, and possibly of the whole stretch of islands between. The modern Asiatic representatives are far from being a consistent physical type, and vary considerably, especially in respect to head length. But the fossil remains that are referred to this stock, such as the Wadjak skulls in Java, the Talgai and Cohuna skulls in Australia, an Australoid skull found in the Madras presidency, a skull found by Mansuy and Colani in Tonkin, all dating back probably to the close of the quaternary period and described as proto-Australoid, were definitely dolichocephalic. Support is thus lent to Dixon's view that the greater brachycephaly of the modern Veddoids is derived from mixture with other peoples of the region.

It is to the Indonesian race that the Ifugaos quite evidently belong, and they are one of the purest representatives of it.

Other representatives are the Bontoks, Kenkanai, and Nabaloi, neighboring tribes, and the Manobo and Bogobo in Min-

[4] Sullivan appears to consider that the hair of deutero-Malays is less frequently wavy than that of the Indonesians. Comparative data not being available, such an assumption is extremely hazardous.

danao, the Muruts, Dusuns, Land Dayaks, and Kenyas of Borneo, and the Tenggorese of Java. Such tribes as the Batak and Menangkabau of Sumatra, the Kayan of Borneo, and the Ilongot and Tagakaolo of the Philippines, having cephalic indices of about 81.5, may be regarded as crosses between Indonesians and deutero-Malays.

Outside the East Indian Archipelago the following are some of the peoples who may be referred to this race:

TABLE 8.—*Indonesian peoples outside the East Indian Archipelago.*

People.	Stature.	Cephalic index.	Nasal index.
Angami Nagas, Assam [a]	.....	76	79
Sema Nagas [a]	.....	79	80
Rengam Nagas [a]	.....	79	82
Kenya Nagas [a]	.....	77	89
Miao, of Tonkin [b]	155	80	.....
Moi, See Chuan	157	77	.....
Chingpo (Kachin)	160.0	75.6	80.8
Yap Islanders	163.7	77.7	85.7
Southern Carolinas [c]	171.0	78.5	75.4

[a] Hutton (8, p. 437) states that the hair of the Nagas is usually straight but sometimes wavy. Average stature is said to be about 160 cm.

[b] Denniker (8, p. 288).

[c] Rickstedt, p. 651. This author declares the Micronesians to be strongly "palæomongoloid-Wedda," increasingly so the further west one goes, and connects them with the Indonesians of Luzon.

Most authorities derive the Indonesian race from a proto-Mongolic stock, to which has been added a pre-Dravidic strain in greater or lesser measure. Buxton, Haddon, Elliot Smith, and others, consider that there is a strong Mediterranean element in this race; indeed, Elliot Smith appears to consider the Mediterranean element to have been first on the ground, even in Indonesia. A number of authorities hold that an Alpine element also entered into the formation of the proto-Mongolian stock. The proto-Mongolian stock, leaving its Asiatic home before the development in great measure of the traits that we regard as specific to the Mongols, migrated southward into Indo-China and northward into Siberia, and thence to America. The southern stream of proto-Mongols met Mediterraneans and probably proto-Australoids in southern Yunnan perhaps, and in northern Indo-China, which regions may be regarded as the cradle of the Indonesian race. The investigations of Chi Li lead him to the conclusion that the Shans, the ancestors of the

modern Siamese beginning about 700 B.C., were pressed southward into Yunnan by the We-group and thence into the valley of the Mekong River. (7, p. 258) This great population movement right through the cradle of the Indonesian race must have driven some members of this race before it down the Malay Peninsula and out into the East Indian Archipelago, and pressed others to either side into the mountain regions they still occupy (Naga tribes, Miao, Lolo, Chingpo, and others).

On the basis of ethnographic data it is safe to conclude that the Ifugao tribe was formed from several streams of migrants into the present habitat. Beyer has noted that the rice fields are older on the west side of the habitat, whence it may be concluded that the stream of migrants that entered from the West were the carriers of irrigated terrace rice cultivation. Perhaps they were pushed over the mountain range by streams of succeeding immigrants, the ancestors of the present Nabaloi, Kankanai, and Bontoks. An exceedingly high proportion, perhaps three-fourths of the cultural traits of all these northern Luzon tribes, is paralleled in one or another of the Naga tribes. For example, the two Ao Nagas with freshly trimmed hair shown in Hutton's book, "The Angamai Nagas," might easily be taken for Ifugaos, since the features are nearly the same and the haircut is exactly the same as the Ifugao haircut. This coiffure is not found except in northern Indo-China and among the Ifugaos. We conclude therefore that it did not diffuse from one people to another, but that it was carried by one stream of Ifugao migration directly from Indo-China to the Philippines. There it must have been adopted by other streams of migrants pouring into the present habitat after having made the long trek southward through the Malay Peninsula, Borneo, Celebes, and north through the southern islands of the Philippine Archipelago. Hose and McDougall call attention to the numerous cultural traits shared in common by the tribes of Northern Indo-China with the Kayans, Kenyas, and other tribes of Borneo. Northern Indo-China may be regarded as the cultural cradle of the Indonesian race as well as its somatological cradle.

Insofar as it may be due to racial rather than environmental factors, the wide nose of some Indonesian groups may be regarded as evidence of a Veddoid admixture. Probably the typical "Veddoid notch"—the form of the nasion depression in

which the forehead juts out over the nose giving the countenance the expression of a perpetual frown is the best guide to Veddoid admixture.

The 24 per cent occurrence of the epicanthus, the narrow eye slit, scanty beard and body hair, as well as the coarse, predominatingly straight character of the hair, link the Ifugao unmistakably with the Mongolian race.

But the Ifugao and the Indonesian type are sharply marked off from the more representative Mongoloid races of central Asia, Siberia, and northeastern Asia by the coincidence of a high skull, very coarse hair, low face, and small frequency of epicanthus. In the Asiatic regions named, coarse hair and weak hairy covering on the face and body are accompanied by a very high face, a low vault of the skull, and a very high development of the epicanthus. The hair, too, of some of these Asiatic groups is not so stiff and straight as that of the Ifugaos. Thus stiff hair was observed in only 33 per cent of the cases among the Kalmyks, while the epicanthus was present in 49 per cent of the cases (Cheboksarov). Taking into consideration the historically established fact of European admixture, to this group of Kalmyks must be attributed a formerly stiffer form of hair, as likewise a greater frequency of the epicanthus. The Tungus of the northern pre-Baikal strip have hair that, while predominatingly straight, can rarely be called stiff; in 7 per cent of the cases soft hair is encountered. The epicanthus is present in 65 per cent of the cases (Roginsky). Measurements on skulls of the height of the face, expressed in percentages of the height of the skull,

$$\frac{\text{Nasion—prosthien}}{\text{Nasion—bregma}} .100$$

gave an average for Kalmyks of 57.7 and for Tungus of 58.9 (J. J. Roginsky).

These high ratios, characteristic of peoples of typically Mongoloid race and apparently differentiating them from all other races of the earth, are not found among the Indonesian types. Taking into consideration the fact that the value of the craniofacial index is dependent mainly on the height of the face, it can be concluded that this index is considerably lower for the Ifugaos than the indices that are characteristic for the Mongol peoples of the continent. This supposition is indirectly con-

firmed by craniological data on the Tagalogs, calculated from the materials published by G. von Bonin,(3) among whom the index is 51. Among the Javanese it is 52.3 and among the Burmans it is 52.5.

Such a coincidence of stiff hair and scant development of tertiary hairy covering, with such additional traits, so rarely found among the typical Mongoloids, as a low face, high skull, and slight development of the epicanthus, has been found in only one other part of the world, namely in America. Absence of epicanthus in adults or a weak development of it is characteristic for the Indians in general. A low vertical craniofacial index is characteristic only for certain groups of Indians, especially for the Indians of northern California (52.1), those near San Francisco (52.1) for the Algonquins of Kentucky (50.5) for the East-Central Algonquins, and, apparently for a number of South American tribes.

These facts do not mean that the American Indians ought to be considered as forming a single race with the Indonesians. There are rather great differences between the types, for example in bigonial width (greater among the Indians), form of the nose, slant of the forehead, development of the brow-ridges, and other characters. However, these differences do not throw into the shade the quite important traits common to both races that may be explained on the ground that some time in the past, and from somewhere in eastern Asia, two streams of human beings migrated, one to the north and northeast into America and the other to the south to Indonesia and Oceania. The divergences in type that are now seen may have resulted from such causes as (*a*) prolonged local differentiation; (*b*) mixture of the Indonesian race with southeastern Asiatic Veddoids, a mixture that appears to be greatest in the southern regions and islands of this part of the world; (*c*) local differences in the groups where the two streams of migrants originated; mixture of the Indonesians with deutero-Malays in whom the Mongoloid traits are more highly developed, especially the Mongoloid fold, brachycephaly, the bridge of the nose, and the bones of the face.

The data here presented contribute to no new hypothesis; they add just a mite of evidence to confirm the views already advanced by Kroeber, Eicksted, Hrdlicka, Buxton, E. Smith, and other authorities that there is a two-fold division of the

Malaysian race, that the subrace variously denominated but here called "Indonesian" derives from an ancient, as yet unspecialized, proto-Mongoloid or palæo-Mongoloid race and so has a kindred origin with the American Indians.

SUMMARY

Measurements made by Barton on 107 Ifugao men and 15 women show this tribe to be typical for the branch of the Maritime Malays usually called the Indonesians, or proto-Malays. The average of all males for stature was 157.2 cm; for cephalic index, 75.34; for nasal index, 85.05. Epicanthus was present in about 24 per cent. Shovel teeth were definitely absent in 23.5 per cent, definitely present in 56.4 per cent, and probably present, but not pronounced in 20.1 per cent.

The dolichocephaly of the Ifugao, their usually straight eyes, and the low incidence of epicanthus, lend credit to the hypotheses of Buxton, Haddon, and Elliot Smith that there is a strong Mediterranean element in the Indonesians. However, these traits might also have been derived from an infusion of pre-Dravidian blood.

Going farther afield, we find that Ifugao affinities are definitely not with the more representative races of Central Asia, Siberia, and northeastern Asia. They are delimited by the Ifugaos' relatively high skull vault, stiffer hair, lower incidence of epicanthus, and shorter face.

On the other hand, these same characters connect the Ifugaos with the American Indians. Indeed, only in America, so far as has been reported, are similar craniofacial indices to be found.

The question raised in this paper of a high incidence of distal occlusions of the mandible in the Hapao area deserves further investigation.

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STUDIES ON PHILIPPINE KINGFISHERS, II

GENERA ALCEDO, HALCYON, AND RAMPHALCYON, WITH ADDITIONAL NOTES ON THE GENUS CEYX

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ONE PLATE

The present paper is the continuation of a previous study [1] and completes the series dealing with Philippine kingfishers. Before presenting the results of the present study, however, I would like to make a few corrections and additions to the first part of this series, which deals with the Philippine forms of the Genus *Ceyx*.

The distribution of *Ceyx cyanopectus nigrirostris* [2] includes Cebu, Negros, and Panay. Specimens from Panay were examined.

A collection of birds from Tawitawi that was received after the publication of the paper on *Ceyx* [3] included interesting specimens of three-toed kingfishers which for convenience should be recorded here. A single female *Ceyx rufidorsus rufidorsus* was taken June 24, 1940. Comparison of this specimen with those from Palawan and Busuanga shows no difference. A male and a female *Ceyx lepidus margarethæ* were also obtained. They are similar to the single female specimen from Basilan reported in the preceding paper.

The most interesting three-toed kingfishers obtained in Tawitawi are a pair of an apparently new form, which I propose to call:

CEYX GOODFELLOWI VIRGICAPITUS subsp. nov. Plate 1.

Type.—Adult male, Philip. Nat. Hist. Mus. 15281, Batobato, Tawitawi, Philippines, June 13, 1940. *Manuel Celestino* and *G. L. Alcasid.*

Characters.—From *Ceyx lepidus margarethæ* of Basilan, Negros, Tawitawi, and elsewhere, the present subspecies differs

[1] Philip. Journ. Sci. 69 (1939) 377–387, pl.
[2] Ibid., p. 380.
[3] *See* footnote 1.

in having most of its upper surface cobalt blue tinged with ultramarine blue instead of blue violet. Its probable closest ally is *Ceyx goodfellowi,* known only from a single specimen obtained in Mindanao and now in the British Museum. *C. goodfellowi virgicapitus* differs from typical *Ceyx goodfellowi,* according to the description of the latter (22) in having the blue of its crown appearing more or less spotted with a deeper shade of cobalt blue. This appearance is due to short median streaks at the distal portion of each feather.

Range.—This form has been found so far only in the forests of Tawitawi.

Description of type.—Upper surface, sides of head, neck, and wings cobalt blue, tinged with ultramarine blue on crown, nape, back, and wing coverts; exposed portion of some feathers of head, neck, and lesser coverts medially streaked with deeper cobalt blue, causing a more or less spotted appearance; lores, cheeks, and most of under parts rufous or orange rufous; chin and throat white with a slight yellow wash; outer web of first alula and of outer first primary rufous, tail black with bluish wash. Iris dark brown; bill, feet, and nails bright vermillion.

Measurements, wing, 64 millimeters; tail, 22; culmen from nostril, 31; tarsus, 10.

The paratype, an adult female, Philip. Nat. Hist. Mus. 15282, has a lighter tinge of ultramarine blue, as a result of which the streaks on the feathers of the head become more manifest.

Measurements, wing, 68 millimeters; tail, 24; culmen, 31; tarsus, 10.

The present study on four-toed Philippine kingfishers follows the general lines of the first part of this series. In addition to materials in the Natural History Museum (formerly the Bureau of Science collection) kingfishers in the private collection of Mr. Graciano Castañeda were examined. The birds treated here differ from those belonging to the Genus *Ceyx* principally in their possession of four toes.

Key to the genera of four-toed Philippine kingfishers.

a.[1] Bill longer than tail ..... *Alcedo.*
a.[2] Bill shorter than tail.
b.[1] Bill and culmen rounded ..... *Halcyon.*
b.[2] Bill compressed, culmen flattened ..... *Ramphalcyon.*

Genus ALCEDO Linnæus, 1758

Small kingfishers; sexes slightly dissimilar; bill compressed, longer than tail; culmen rounded, slightly curved with a light groove on either side; feet weak. Two species occur in the Philippines.

Key to the Philippine species of Alcedo.

a.[1] Underparts light orange-rufous; wing coverts spotted with greenish cobalt ..... A. *atthis.*

a.[1] Underparts deep chestnut-rufous; wing coverts spotted with purplish blue ..... A. *meninting.*

ALCEDO ATTHIS BENGALENSIS Gmelin.

Alcedo bengalensis GMELIN, Syst. Nat. pt. 1 1 (1788) 405; in LE MARTIN, Pecheur de l'Isle de Luzon; SONNERAT, Voy. Nov. Guin. (1776) 67, pl. 32.

Alcedo ispida SHARPE, Cat. Bds. Brit. Mus. 17 (1892) 150.

Alcedo ispida bengalensis HARTERT, Vög. Pal. Faun. 2 (1912) 883.

Alcedo atthis bengalensis LAUBMANN, Verh. Ornith. Ges. Bayern (4) 12 (1916) 241.

Alcedo atthis japonica KURODA, Bds. Is. Java 2 (1936) 407.

Balabac, Bantayan, Basilan, Batan, Bohol, Cagayancillo, Cagayan Sulu, Calamianes, Calayan, Catanduanes, Cebu, Cuyo, Guimaras, Leyte, Lubang, Luzon, Masbate, Mindanao, Mindoro, Negros, Palawan, Polillo, Romblon, Samar, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi, Verde.

Specimens from Alabat, Bohol, Cagayancillo, Cagayan Sulu, Calayan, Cebu, Cuyo, Lubang, Luzon, Mindanao, Mindoro, Negros, Palawan, Polillo, and Siquijor were examined.

Upper surface generally dark greenish blue, cobalt in middle; head barred with cobalt and bluish black; in males a band of ferruginous extends from lores backward to white ear patch; below the ferruginous loral band a wider greenish-blue band spotted with cobalt and extending from base of lower mandible to below ear patch; under parts rufous except chin and throat, which are whitish buff. Females have duller color.

Measurements of Alcedo atthis bengalensis, based on 38 males and 35 females.

	Range. mm.	Mode. mm.
Wing	69–75	72
Tail	29–35	31
Culmen from nostril	30–34	32
Tarsus	7– 9	8
Middle toe with claw	16–17	17

The range of measurements of the wing (69 to 75 millimeters) corroborates the findings of Streseman.(36) This range was made the basis of Kuroda's(13) allocation of the Philippine form to *Alcedo atthis japonica* Bonaparte. The present study, however, records an average wing measurement, based on 38 males and 35 females, of 71.8 millimeters, while the average measurement made by Stresemann was 71 millimeters. Kuroda(13, p. 406) gives the wing measurement of *Alcedo atthis bengalensis* from Shanghai as 71 millimeters. Males from the Philippines do not differ sufficiently from a male *Alcedo atthis bengalensis* from Amoy, China, to warrant their separation. No birds from Formosa or Japan have been examined.

ALCEDO MENINTING MENINTING Horsfield.

Alcedo meninting HORSFIELD, Trans. Linn. Soc. 13 (1821) 172.
Alcedo asiatica GUILLEMARD, Proc. Zool. Soc. London (1885) 255.
Alcedo meninting meninting HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 126.

Balabac, Bungao, Calamianes, Palawan, Sulu, Tawitawi.

Specimens from Palawan and Tawitawi were examined.

Smaller than *A. a. bengalensis*. Upper surface generally velvety black; head black, barred with purplish blue; midback, rump, and upper tail coverts cobalt blue; wing coverts black, spotted with purplish blue; outer secondaries margined with purplish blue. Underparts rufous, buffish white on chin and throat. Bill of male dark brown; bill of female dark brown on upper jaw, red on lower.

Measurements of Alcedo meninting meninting, based on 3 males and 3 females.

	Range. mm.	Mode. mm.
Wing	65–66	65
Tail	26–27	27
Culmen from nostril	34–36	35
Tarsus		7
Middle toe with claw	16–17	16

Genus HALCYON Swainson, 1821

Medium-sized kingfishers; bill strong, broad at base; culmen straight and rounded, without groove on either side; wing rounded; tail graduated, longer than culmen.

Six species are known to occur in the Philippines.

Key to the Philippine species of the genus Halcyon.

a.[1] Back spotted ..... *H. lindsayi.*
a.[2] Back unspotted.
b.[2] Crown and back of uniform color.
c.[1] Head and neck partitioned by a collar of distinct color.

d.[1] Head and back blue, collar white ..... *H. chloris.*
d.[2] Head and back deep blue, collar rufous ..... *H. winchelli.*
c.[2] Head and neck not partitioned by a collar of distinct color. *H. coromanda.*
b.[2] Crown and back not of uniform color.
c.[1] Crown chestnut, back blue ..... *H. smyrnensis.*
c.[2] Crown black, back blue ..... *H. pileata.*

Species 1. HALCYON LINDSAYI

HALCYON LINDSAYI LINDSAYI (Vigors).

Dacelo lindsayi VIGORS, Proc. Zool. Soc. London (1831) 97.
Dacelo lessoni VIGORS, ibid.
Halcyon lindsayi GRAY, Gen. Birds 1 (1846) 79, pl. 27.
Actenoides lindsayi WALDEN, Trans. Zool. Soc. London 9 (1875) 156.
Halcyon lindsayi lindsayi HACHISUKA, Birds Philip. Is. pt. 3 (1934) 144, pl. 16.

Luzon.

Specimens from Luzon have been examined.

Sexes dissimilar. Upper parts generally green, forehead with a few buff feathers, lores and nape black; scapulars, mantle, and wing coverts with whitish buff spots. Underparts largely with green trimmings. In the male the crown is largely bordered by a blue band, followed by a black band, then a cinnamon band. Upper cheeks, chin, and throat cinnamon, this color enclosing a bright-blue patch on lower cheeks upon meeting the cinnamon band of the neck behind. In the female the blue color on cheeks in the male replaced by green, the cinnamon of chin and throat by whitish buff.

Measurements of Halcyon lindsayi lindsayi, based on 13 males and 10 females.

	Range. mm.	Mode. mm.
Wing	104–112	108
Tail	80–89	86
Culmen from nostril	30–37	35
Tarsus	17–19	18
Middle toe with claw.	27–28	27

HALCYON LINDSAYI MOSELEYI (Steere).

Actenoides Moseleyi STEERE, List Birds and Mamm. Steere Exped. (1890) 11.
Halcyon moseleyi SHARPE, Cat. Birds Brit. Mus. 17 (1892) 288.
Halcyon lindsayi moseleyi HACHISUKA, Birds Philip. Is. pt. 3 (1934) 145.

Negros.

A female specimen was examined.

Similar to the female of *H. lindsayi lindsayi* but edge of breast feathers black instead of green.

Measurements of a female *H. lindsayi moseleyi:* wing 107 millimeters; tail 80; culmen from nostril 38; tarsus 16; middle toe and claw 27.

HALCYON LINDSAYI HOMBRONI Bonaparte.

Actenoides hombroni BONAPARTE, Consp. Gen. Avium 1 (1850) 157.
Halcyon hombroni SHARPE, Mon. Alcedinidae (1870) pl. 84.

Mindanao.

Specimens from this island have been examined.

Sexes dissimilar. In male the crown, nape, and cheeks deep blue, approaching Hay's Blue in Ridgway's Color Standards and Color Nomenclature. Exposed midback, scapulars, and wing coverts generally green spotted with buff, the spots gradually reduced in number and in size from before backwards; lower back, rump, and upper tail coverts cobalt; tail blue with black shafts. Chin, throat, and midabdomen buffy white, rest of underparts buff, some feathers with fine black trimmings. In the female the crown is green and the cheek band is tawny with a greenish-brown wash.

Measurement of the Halcyon lindsayi hombroni based on 4 males and on 3 females.

	Range. mm.	Mode. mm.
Wing	120–122	122
Tail	88–95	89
Culmen from nostril	32–37	34
Tarsus	16–17	17
Middle toe with claw	26–29	28

This form shows specific affinity with *Halcyon lindsayi.* The main difference lies in the blue color of the head (in males only), the cobalt blue of the lower back, rump, and upper tail coverts, and the blue tail of *H. l. hombroni.* All these parts are more or less greenish in *H. l. lindsayi* and in *H. l. moseleyi.* The general pattern of the scapulars and wing coverts of *H. lindsayi lindsayi, H. lindsayi moseleyi,* and *H. lindsayi hombroni* is dark brown with greenish sheen spotted with buff. The chin and throat of the male *H. lindsayi lindsayi, H. lindsayi moseleyi,* and of *H. lindsayi hombroni* are of varying shades of buff or cinnamon. The buff breast, flanks, and abdomen of *H. l. hombroni* is merely an intensification of what is already slightly manifest in the abdomen of the other two races, while the nearly obsolete black trimmings on the feathers of the underparts is a reduction of those prominent in the other races. This color character gradient, however, is more discernible in the females of the three

races. These characters, in addition to the facts presented by their distribution, will lead to their conspecific affiliation.

Species 2. HALCYON CHLORIS

HALCYON CHLORIS COLLARIS (Scopoli).

Halcyon chloris collaris (Scopoli) LE MARTIN, Pecheur a collier blane des Philippines; Sonn. Voy. Nouv. Guinee (1776) 67, pl. 38.
Alcedo collaris SCOPOLI, Del. Flor. et Faun. Insubr. 2 (1786) 90.
Halcyon chloris WALDEN and LAYARD, Ibis (1872) 96.
Sauropatis chloris TWEEDDALE, Proc. Zool. Soc. London (1877) 690.
Sauropatis chloris collaris OBERHOLSER, Proc. U. S. Nat. Mus. 55 (1920) 361.

Bantayan, Banton, Basilan, Batan, Bohol, Bungao, Cagayancillo, Cagayan Sulu, Calamianes, Caluya, Camiguin Norte, Camiguin Sur, Catanduanes, Cebu, Cuyo, Dinagat, Fuga, Guimaras, Lapac, Leyte, Lubang, Luzon, Maestre de Campo, Marinduque, Masbate, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Romblon, Sibay, Samar, Semirara, Sibutu, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi, Ticao, Verde, Y'Ami.

Specimens from Alabat, Apo, Bantayan, Bohol, Bungao, Cabancauan, Camiguin, Cuyo, Fuga, Gigante Norte, Jinamoc, Jolo, Leyte, Lubang, Luzon, Mindanao, Mindoro, Negros, Palawan, Panay, Pearl Bank, Polillo, Samar, Semirara, Siasi, Sibuyan, Siquijor, Tablas, and Tubbataha Reef were examined.

Sexes slightly dissimilar. In males upper parts generally greenish blue; wings, back, rump, and tail blue; behind nape a distinct white collar. Underparts white. Females are slightly duller on the upper parts.

Measurments of Halcyon chloris collaris, based on 62 males and 60 females.

	Extremes. mm.	Mode. mm.
Wing	105–112	109
Tail	63– 69	66
Culmen from nostril	38– 42	40
Tarsus	14– 16	14
Middle toe with claw	24– 26	25

The uniformity of specimens in the wide range from which they were collected indicates that only one race exists in the Philippines.

Species 3. HALCYON WINCHELLI

HALCYON WINCHELLI Sharpe.

Halcyon winchelli SHARPE, Trans. Linn. Soc. London II (1876) 318, pl. 47.
Halcyon alfredi OUSTALET, Le Naturaliste (1890) 62.
Halcyon winchelli winchelli HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 41.

Basilan, Bohol, Bungao, Cebu, Mindanao, Papahag, Romblon, Samar, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi.

Specimens from Basilan, Bohol, Mindanao, Sibuyan, Tablas, and Tawitawi were examined.

Sexes dissimilar. Upper surface generally deep blue, a lighter blue line above eye extending backward, meeting its fellow on nape and forming a U; lores and a narrow collar rufous, back, rump, and upper tail coverts silvery blue. Underparts white in male, whitish buff in female.

Measurements of Halcyon winchelli, based on 10 males and 12 females.

	Extremes. mm.	Mode. mm.
Wing	100–107	104
Tail	67– 74	68
Culmen from nostril	40– 48	42
Tarsus	13– 15	14
Middle toe with claw	21– 26	25

Hachisuka splits *Halcyon winchelli* into two races, naming the Negros form *Halcyon winchelli nigrorum.* In the present study no specimen from Negros was examined. In spite of similarities of the specimens from the islands named, the bird from Negros, in the center of its distributional area, is regarded by Hachisuka as distinct. In any case Hachisuka's opinion should be respected as it was on actual observation. Peters (24, p. 98) has a remark on this matter.

Species 4. HALCYON COROMANDA

HALCYON COROMANDA OCHROTHORECTIS (Oberholser).

Calialcyon coromanda WALDEN, Trans. Zool. Soc. London pt. 2 9 (1877) 155.

Halcyon coromandus SHARPE, Cat. Bds. Brit. Mus. 17 (1892) 217.

Entomothera coromanda ochrothorectis OBERHOLSER, Proc. U. S. Nat. Mus. 48 (1915) 652.

Halcyon coromanda bangsi HACHISUKA, Bds. Philip. Is. pt. 3 2 (1934) 138.

Halcyon coromanda ochrothorectis HACHISUKA, Bds. Philip. Is. pt. 3 2 (1934) 139.

Batan, Calayan, Camiguin Norte, Guimaras, Luzon, Masbate, Mindanao, Mindoro, Palawan, Sibuyan.

Specimens from Calayan, Luzon, and Mindoro were examined.

Sexes very slightly dissimilar. Upper parts generally dark rufous washed with violet. Lower back, rump, and upper tail coverts bluish silvery white. Underparts buff. Violet wash on upper parts of male more pronounced than in corresponding parts of female.

Measurements of Halcyon coromanda ochrothorectis, based on 5 males and 3 females.

	Extremes. mm.	Mode. mm.
Wing	120–126	122
Tail	66– 70	67
Culmen from nostril	43– 48	47
Tarsus	15– 17	16
Middle toe with claw	27– 29	28

When Oberholser(20, p. 652) described *Entomothera* (= *Halcyon*) *coromanda ochrothorectis* from Masbate, he had occasion also to indicate the measurements of specimens from Calayan, Luzon, Mindoro, and Mindanao. In addition, he hinted that the race was reported from Tawitawi, presumably on the basis of a report by Bourns and Worcester.(3) Notwithstanding this citation, Oberholser (20, p. 649) mentions Tawitawi as a locality for *Entomothera coromanda minor*, when he says "a single immature specimen from Tataän, on Tawitawi Island, in the southwestern part of the Philippine Archipelago, is apparently typical of *Entomothera coromanda minor*." No reference was made to the collector, but it is very likely that this specimen was the one reported by Bourns and Worcester(3) as *Halcyon coromandus* from Tawitawi and later suggested by Oberholser to be *E. c. ochrothorectis*. On the other hand, Hachisuka(9) named two races of *Halcyon coromanda* as inhabiting the Philippines; namely; *H. c. bangsi* in Batan, Calayan, Camiguin Norte, Luzon, and Mindoro, and *H. c. ochrothorectis* in the southern islands.

The only specimen examined from Tawitawi in the present study proves to be

HALCYON COROMANDA MINOR (Temminck and Schlegel).

Halcyon coromanda ochrothorectis HACHISUKA, Birds Philip. Is. pt. 3 (1934) 139.

Measurements of female *H. c. minor* from Magsakaw, Tawitawi Island, collected by Manuel Celestino and Godofredo Alcasid, July 5, 1940; wing 106 millimeters; tail 61; culmen from nostril 49; tarsus 15; middle toe and claw 22.

This bird differs from *H. c. ochrothorectis* not only in its much reduced size but also in having the upper and underparts much darker.

Species 5. HALCYON SMYRNENSIS

HALCYON SMYRNENSIS GULARIS (Kuhl).

Alcedo gularis KUHL in Buff. and D' Aubent, Fig. Av. Col. Nom. Syst. (1820) 4.

Halcyon gularis SHARPE, Mon. Alced. (1870) 165, pl. 60.

Halcyon smyrnensis var. *albogularis* BLYTH, Journ. Asiat. Soc. Bengal 11 (1843) 99.
Entomobia gularis WALDEN, Trans. Zool. Soc. London 9 (1875) 154.
Halcyon smyrnensis gularis LAUBMANN and GÖTZ, Verh. Orn. Ges. Bayern 17 (1926) 44.

Basilan, Bohol, Caluya, Cebu, Guimaras, Leyte, Libago, Lubang, Luzon, Maestre de Campo, Marinduque, Masbate, Mindanao, Mindoro, Negros, Panaon, Panay, Polillo, Samar, Sibay, Siquijor, Tablas, Ticao, Verde.

Specimens from Alabat, Bohol, Catanduanes, Cebu, Leyte, Luzon, Mindanao, Mindoro, Negros, Panay, Samar, and Siquijor were examined.

Sexes similar. Head, neck, lores, and cheeks deep chestnut; scapulars and outer web of basal part of a number of primaries bright blue; portion of inner web white, otherwise black like distal part; secondary coverts black; tail blue; back and rump cobalt blue; chin and throat white; otherwise lower surface chestnut, slightly lighter than head. In fresh specimens bill, legs, and feet red.

Measurements of Halcyon smyrnensis gularis, based on 44 males and 42 females.

	Range. mm.	Mode. mm.
Wing	121–129	126
Tail	79– 83	80
Culmen from nostril	50– 54	52
Tarsus	12– 14	13
Middle toe with claw	26– 29	28

No difference was noted between the measurements of the male and those of the female.

Species 6. HALCYON PILEATA

HALCYON PILEATA (Schlegel).

Dacelo pileata SCHLEGEL, Vog. Ned. Ind. Alced. 2 (1864) 22, 54.
Halcyon pileata SHARPE, Ibis (1888) 197.
Entomobia pileata WALDEN, Trans. Zool. Soc. London 9 (1875) 154.

Balabac, Basilan, Palawan, Tawitawi.

A specimen bearing no locality was examined.

Genus RAMPHALCYON Reichenbach, 1851

Large kingfishers; sexes dissimilar; bill compressed, heavy, shorter than tail; culmen flattened, straight, and grooved on either side.

Sharpe(29) recorded three species (*Pelargopsis leucocephala* = *P. javana*, *P. gigantea*, and *P. gouldi*) from the Philippines.

Oberholser,(19) basing his conclusions on a large series of specimens, lumped the Philippine forms into one species with two subspecies; namely, *Ramphalcyon capensis gigantea* and *R. c. gouldi*. Mearns later in the same year(18) added *R. c. smithi* with "southeastern Luzon, Masbate and others of the middle islands of the Philippines, where the ranges of *R. c. gigantea* and *R. c. gouldi* approach each other" as its geographical range. In addition, Mearns claims *R. c. smithi* to be the largest Philippine form. The present study brought out a few facts concerning *R. c. smithi* Mearns. A female bird from Masbate has a wing measurement of 164 millimeters. Its color, however, is typical of *R. c. gigantea*. The wing measurement of this bird shows that it is indeed much larger than many specimens of *R. c. gigantea* as reported by previous writers. In the latter part of the present paper, however, specimens of *R. c. gigantea* will be shown to have wing measurements about as great as or greater than that of the wing of the bird from Masbate. A female bird from Sibuyan possesses a color intermediate between that of *R. c. gigantea* and *R. c. gouldi*, and has a wing measurement of 164 millimeters. These characters would fit in nicely with *R. c. smithi*. However, another female bird from the same locality possesses a color typical of *R. c. gigantea*. Sibuyan Island is about 30 miles (about 48 kilometers) from Masbate across the channel.(38) Obviously, this is one of the islands assumed by Mearns to be a locality for *R. c. smithi*. The lone bird examined from Ticao, on the other hand, is, from all indications, a typical *R. c. gigantea;* yet Ticao is less than 2 kilometers from the nearest point in Masbate and lies between Masbate and the southernmost tip of Luzon, assumed, beyond doubt, by Mearns as another locality for his *R. c. smithi*. Hence Oberholser(19) may be right when he states that "individual variation is not unusually great" and that specimens of the Philippine stork-billed kingfisher heretofore identified as *R. c. smithi* are obviously variants of *R. c. gigantea*. The birds examined from Polillo are also identical with typical *R. c. gigantea*.

Key to the Philippine subspecies of Ramphalcyon capensis.

a.[1] Head, neck, and underparts deep orchraceous ..... *R. c. gouldi.*
a.[2] Head, neck, and underparts cream or pale buff ..... *R. c. gigantea.*

RAMPHALCYON CAPENSIS GOULDI (Sharpe).

Pelargopsis gouldi SHARPE, Proc. Zool. Soc. London (1870) 63.
Pelargopsis leucocephala SHARPE, Ibis (1884) 318.
Ramphalcyon capensis gouldi OBERHOLSER, Proc. U. S. Nat. Mus. 35 (1909) 667.

Balabac, Calamianes, Lubang, Luzon, Mindoro, and Palawan. Specimens from Lubang, Mindoro, and Palawan were examined.

Measurements of R. c. gouldi, based on 11 males and 7 females.

	Range. mm.	Mode. mm.
Wing, males	139–171	142
Wing, females	149–175	150
Tail	88– 94	92
Culmen from nostril	69– 76	70
Tarsus	14– 16	15
Middle toe with claw	31– 25	32

The females examined have slightly longer wings than the males, corroborating the measurements taken by Oberholser.(19) In this study, however, no difference was noted between the measurements of the tail of the male and those of the female, although the tails of two males were 88 millimeters each, while others, including males and females, had tails 90 to 94 millimeters long. Oberholser(19) found a decided difference between the length of the tail of the male and that of the female of this kingfisher, being an average of 83 millimeters in the male and 93.5 millimeters in the female.

According to the literature, this stork-billed kingfisher was recorded in Luzon but once, when Sharpe(28) described a bird collected by Hugh Cuming. The locality, however, as in the case of much other material collected by Cuming, appears open to question, as may be gleaned from the following considerations. In the original description Sharpe gave "Philippines, Island of Luzon" as the habitat of this bird. The date of collection was not given. In a later paper Sharpe(31) identified the stork-billed kingfisher from southern Palawan, collected by Lempriere as *Pelargopsis leucocephala.* The stork-billed kingfisher from Palawan is now acknowledged to be typical *P. gouldi.* In the Catalogue of Birds, Sharpe(33) mentioned his type specimen of *P. gouldi,* specifying Manila as its locality. In addition, the bird collected by the "Challenger" Expedition from Iloilo (Panay Island) which was, according to our present knowledge, rightly labelled, but with doubt, by the Marquis of Tweeddale(37) as *Pelargopsis gigantea,* and the bird obtained by Lempriere from southern Palawan, were identified by Sharpe(31) as *P. gouldi.* It thus appears that Sharpe, in citing the locality in the original description of *P. gouldi* and

in identifying the bird from Palawan, was not certain about the true identity of his *P. gouldi.*

McGregor(16) included Luzon and Palawan as localities for *P. gouldi,* but eliminated Panay and placed it as a locality for *P. gigantea.* Obviously the inclusion of Luzon was based on Sharpe's previous description which McGregor had not been able to confirm. The island of Mindoro, on the basis of specimens collected by the Steere Expedition, was also included as a locality for *P. gouldi.* Oberholser,(19) on the basis of a specimen of *P. gigantea* obtained by Dr. E. H. Porter from Sorsogon and apparently confirming the latest statement of Sharpe, limited the distribution of *P. gouldi* to the southern Philippines (Manila), besides Balabac, Calamianes, Lubang, Mindoro, and Palawan. McGregor(17) recorded *P. gigantea* from Polillo, although he was expecting to find *P. gouldi* there on the basis of previous reports of Sharpe. Hachisuka(9) insisted McGregor obtained *P. gouldi* and not *P. gigantea.*

Hachisuka,(8) referring to Hugh Cuming's collection in the Philippines of which the type of *P. gouldi* was a part, says:

> He (Cuming) resided for a long time in the Philippines, between 1836 and 1839, but as his large collection of birds was broken up without being catalogued (having been brought to Europe at a time when geographical distribution attracted less attention than now), we possess no published record of the exact localities where his specimens were obtained.

The interesting account of Rolfe(25) about the fate of Cuming's botanical collection and the statement that the latter visited Mindoro during his sojourn in the Philippines, in addition to later findings that *R. c. gigantea* inhabits Luzon, leads me to believe that Cuming obtained the type of *P. gouldi* from Mindoro, where the bird is relatively common. There is good reason to believe, on the basis of the foregoing circumstances, that in describing *P. gouldi* Sharpe was influenced by H. Cuming's letter,(4) dated at Manila, to the Zoological Society of London, advising the latter of a collection of birds and quadrupeds which he was forwarding from the southern part of Luzon. If it could be definitely proven that the type of *P. gouldi* was collected in Mindoro, the confusion of writers subsequent to Sharpe(29) wouuld be cleared up and henceforth due acknowledgment made of the fact that only *P. gigantea* occurs in Luzon, and that Mindoro is the type locality of *P. capensis gouldi.*

RAMPHALCYON CAPENSIS GIGANTEA (Walden).

Pelargopsis gigantea WALDEN, Ann. & Mag. Nat. Hist. IV 13 (1874) 123.

Ramphalcyon capensis gigantea OBERHOLSER, Proc. U. S. Nat. Mus. 35 (1909) 668.

Basilan, Bohol, Bungao, Cebu, Dinagat, Guimaras, Lapac, Leyte, Luzon, Masbate, Mindanao, Malanipa, Negros, Panay, Polillo, Salok, Samal, Samar, Sibutu, Sibuyan, Sulu, Tawitawi, Ticao.

Specimens from Basilan, Biliran, Bohol, Cebu, Leyte, Luzon, Masbate, Mindanao, Polillo, Samar, Sibuyan, Suluan, Tawitawi, and Ticao were examined.

Measurements of R. c. gigantea, based on 15 males and 13 females.

	Range. mm.	Mode. mm.
Wing, males	152–155	153
Wing, females	157–170	164
Tail, males	89–93	90
Tail, females	94–103	94
Culmen from nostril	66–75	67
Tarsus	14–16	14
Middle toe with claw	34–40	35

The measurements show that the wing and tail of the female are, on the average, longer than the corresponding parts of the male.

The lone specimen from Luzon studied was collected from Dupax, Nueva Vizcaya Province, in the northern part of Central Luzon. The race appears to be very rare in this Island. Another bird was seen on the wing along the river in Aloneros, Tayabas Province, in southern Luzon.

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ILLUSTRATION

[Drawing by Francisco Rafael.]

PLATE 1. *Ceyx goodfellowi virgicapitus* subsp. nov.

PLATE 1. CEYX GOODFELLOWI VIRGICAPITUS SUBSP. NOV.

SOME PHILIPPINE CERAMIC MATERIALS

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The value of ceramic products imported into the Philippines in 1938 amounted to nearly four million pesos.[1] Lately there has been some advance in the development of local ceramic industries. However, further research on ceramic raw materials is necessary for the proper encouragement of these industries. The present paper gives an account of recent investigations along this line.

BRICK AND TILE CLAYS

Brick and tile clays are found in many places in the Philippines. At present bricks are manufactured on a small scale in Ilocos Sur, Negros Oriental, and Cebu Provinces, and to a large extent in Rizal Province. Hollow bricks and tiles are manufactured at Tinajeros, near Manila, by the Ceramic Industries of the Philippines.

The chemical composition and the physical tests of one of these brick clays are given in Tables 1 and 2, respectively.

Table 1.—*Analysis of Philippine brick clay.*[a]

Constituent.	Per cent.
Loss on ignition	13.84
Silica (SiO_2)	51.00
Alumina (Al_2O_3)	20.60
Ferric oxide (Fe_2O_3)	6.36
Lime (CaO)	2.91
Magnesia (MgO)	2.31
Alkalies (Na_2O+K_2O)	3.06

[a] Obtained from San Pedro Macati near Manila.

Table 2.—*Physical tests on Philippine brick clay.*

Test.	Results.
Water of plasticity, per cent	45.96
Linear shrinkage, per cent	10.87
Slaking time, minutes	62
Tensile strength, pounds per square inch	176
Drying qualities	Good
Fusing point[a]	1,200 °C.

[a] Approximate.

[1] One peso equals 50 cents United States currency.

POTTERY CLAY

The making of cooking pots, water containers, flower vases, flower pots, and other similar products is carried out in many provinces, notably Albay, Batangas, Rizal, Bulacan, Pampanga, Pangasinan, La Union, Ilocos Norte, Ilocos Sur, Cebu, Oriental Negros, Leyte, Iloilo, and Capiz. Rice-paddy clays are used with the addition of the fine river sand.

SAND AND OTHER SILICEOUS MATERIALS

Silica is an important constituent of glass and bottles. Deposits of sand and other siliceous materials have been located in Baguio and in Pampanga, La Union, Tarlac, and Mindoro Provinces. The San Miguel Bottle Factory uses the Lubang sand of Mindoro. Because of the presence in some deposits of impurities, usually iron oxides and mica, treatment of the raw materials is necessary for the manufacture of certain products.

Bagasse ash, which is a good source of silica, is found in abundance in the Philippine sugar centrals. Bottles of good quality were made from this material with the addition of other ingredients.

Table 3 shows the average composition of Philippine bagasse ash.

TABLE 3.—*Composition of Philippine bagasse ash.*

Constituent.	Per cent.
Loss on ignition	0–1
Silica (SiO_2)	75–85
Alumina (Al_2O_3)	4–8
Iron oxide (Fe_2O_3)	Seldom 2
Lime (CaO)	2–3
Magnesia (MgO)	1.5–3
Manganese dioxide (MnO_2)	Less than 1
Potash (K_2O)	4–7
Soda (Na_2O)	2–4

KAOLIN

From Laguna, Batangas, Albay, Benguet, Abra, Ilocos Norte, Camarines Norte, Iloilo, and Cebu Provinces white burning clays have been reported. These clays are good sources of kaolin not only for ceramics but also for nonceramic industries. The mining of kaolin is not known in the Philippines.

Table 4 gives the chemical composition of one of these clays.

TABLE 4.—*Analysis of Philippine white clay.*

Constituent.	Per cent.
Loss on ignition	11.59
Silica (SiO_2)	55.99
Alumina (Al_2O_3)	28.77
Iron oxide (Fe_2O_3)	0.89
Lime (CaO)	0.18
Magnesia (MgO)	0.03
Soda (Na_2O)	0.08
Potash (K_2O)	0.09

SUMMARY

The sources of some Philippine ceramic materials together with their analyses are given.

Physical tests of a typical brick clay are included.

The Philippines imported nearly four million pesos worth of ceramic materials and products in 1938. For this reason and because of the existence of suitable raw materials, ceramic industries have a good future in the Islands.

The continuance of studies of possible sources of ceramic materials is recommended.

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TERATOLOGY OF PHILIPPINE ORCHIDS, III

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TWO PLATES

The present contribution is essentially similar to its predecessors.[1] It consists of descriptions of teratological cases in 6 species and 1 variety. All the illustrations were prepared by Mr. R. Aguilar of the Natural History Museum. All specimens reported in this paper are preserved in liquid and deposited with the Philippine National Herbarium.

ARUNDINA BAMBUSIFOLIA Lindl. Plate 2.

This is the first case of teratology observed in this species by the author, despite hundreds of plants under cultivation in his garden with normal flowers. (*a*) Flower with all parts normal except for the absence of one lateral sepal. (*b*) The dorsal sepal and the two petals are normal; conspicuous by the absence of one lateral sepal and the lip. (*c*) All the sepals and petals are present and normal in size and form; conspicuous by the absence of lip.

PHALAENOPSIS AMABILIS (Linn.) Blume. Plate 1, figs. 1 and 2.

Last year the author received several hundred living specimens of this species, collected from Brooks Point, Palawan. In the Philippines this species is limited in distribution, having been reported from Palawan, the Sulu Archipelago, and Tawitawi. In one of the plants received, which flowered last year, an interesting case of teratology occurred. The specimen was the first flower that opened, located at the base of the flower stalk. The case is similar to one in *Phalaenopsis equestris*,[2] reported by the author in 1932. The dorsal sepal, petals, and column are normally developed. The two normal lateral sepals are absent, but in their place a coalesced structure is present, which resembles fused lateral sepals. In shape the coalesced structure resembles the dorsal sepal, except in size, being slightly larger. The labellum is absent.

[1] Philip. Journ. Sci. 49 (1932) 137–141, *3 pls;* 57 (1935) 459–463, *1 pl.*
[2] Philip. Journ. Sci. 49 (1932) 138, *pl. 3, figs. 7–9.*

PHALAENOPSIS APHRODITE Reichb. f. Plate 1, figs. 4 and 5.

Cases of fine pelories were previously reported by Costerus and Smith [3] in *Phalaenopsis amabilis* where the labellum and the petals are alike without any incision or appendage, and the column wanting. Master [4] also reported teratological cases in *Phalaenopsis Schilleriana* and *P. amabilis*, but neither of them cited the teratological phenomenon herein described. Quisumbing [5] reported cases in *P. equestris*, *P. Sanderiana*, *P. Schilleriana*, *P. Stuartiana*, *P. amabilis*, and *P. aphrodite*, but not the kind herein reported.

All the flower parts, like the petals, sepals, column, lip, and callus, are normal in size, form, and color, except for the presence of a small structure at the middle at the base of the middle lobe of the lip. The specimen was collected March 10, 1936, among the plants in flower of Mrs. K. B. Day, Parañaque, Rizal Province.

PHALAENOPSIS STUARTIANA Reichb. f. Plate 1, fig. 3.

The sepals, labellum, and column are all normal in size, but sepals are more decorated with reddish-brown dots. The petals are peculiar and abnormal; they are 3-lobed, with slightly wrinkled margins, and on the surface of each near the base is a small, thin, needlelike structure. The specimen was sent in by Dr. Alexander Gordon of La Carlota, Oriental Negros Province.

VANDOPSIS LISSOCHILOIDES (Gaudich.) Pfitz. Plate 1, fig. 8.

Usually in this species the flower at the very base of the inflorescence is abnormal. The present case is characterized by difference in shape of flower parts and the absence of some parts. The dorsal sepal and petals are elliptic and broader than in the typical flower. The column is practically normal. There is complete absence of the labellum. The typical lateral sepals are absent and replaced by a coalesced, somewhat rounded structure. The author is indebted to Dr. Alexander Gordon of La Carlota, Occidental Negros Province, for the specimens, which were received July 13, 1940.

ARACHNIS LOWII J. J. Sm. Plate 1, figs. 6 and 7.

This is one of the most interesting species of orchids introduced into the Philippines, because of its long, pendant inflor-

[3] Ann. Jard. Bot. Buitenzorg 28 (1914) 133, *t. 26, fig. 14.*
[4] Vegetable Teratology (1869) 262.
[5] Philip. Journ. Sci. 49 (1932) 137–141, *3 pls;* 57 (1935) 459–463, *1 pl.*

escences and the peculiar shape and color of the flowers. The plant in question has flowered twice since its acquisition by Mr. Costenoble of del Carmen, Pampanga Province, who gave the author flowers at both times, although this is the first time this teratological case has occurred. All the flowers at the base of the long pendant inflorescence are abnormal (Plate 2, fig. 6). While all the flower parts are present, they are entirely distinct from the typical flowers (Plate 2, fig. 7) in size, shape of flower parts, and even in color. The petals and sepals are cadmium yellow spotted with dull mahogany red.

RENANTHERA STORIEI Reichb. f. Plate 1, fig. 9.

In many orchids teratological flowers are generally found at the base of the inflorescence. In this case, however, all the flowers of the inflorescence are teratological. All the flower parts are normal in size and color, except the lateral sepals which are joined, the union sometimes extending almost from end to end. Specimens collected from a plant belonging to Mr. M. Sulit of the School of Forestry, Los Baños, Laguna Province, October, 1932.

ILLUSTRATIONS

Plate 1

Figs. 1 and 2. *Phalaenopsis amabilis* (Linn.) Blume.
Fig. 3. *Phalaenopsis Stuartiana* Reichb. f.
Figs. 4 and 5. *Phalaenopsis aphrodite* Reichb. f.
6 and 7. *Arachnis Lowi* J. J. Sm.
Fig. 8. *Vandopsis lissochiloides* (Gaudich.) Pfitz.
Fig. 9. *Renanthera storiei* Reichb. f.

Plate 2

Arundinaria bambusifolia Lindl.

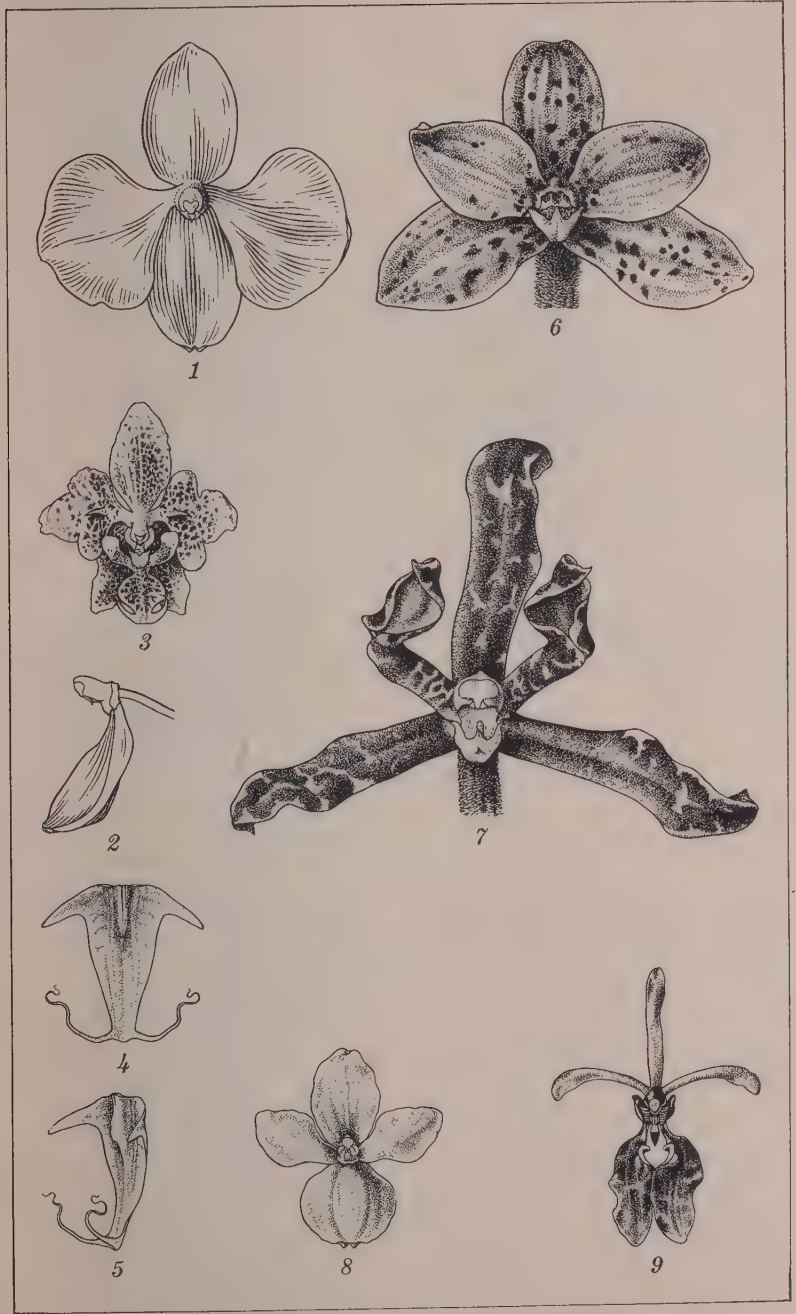


PLATE 1.

PLATE 2.

BOG AND WATER PLANTS OF MANCHURIA, I

THE GENUS POTAMOGETON

By V. I. Kuzmin and B. W. Skvortzow
Of Harbin, Manchoukuo

FOURTEEN PLATES

Although considerable work has been done during the past forty years on the plants of Manchuria, our knowledge with regard to them still remains incomplete. In the present series we intent to publish descriptions and diagrams on the water plants of Manchuria, together with various relevant observations on these plants. The present paper constitutes the first part of this series, and contains the description of species of *Potamogeton* Linn., collected by B. W. Skvortzow in the period 1920–1939, and by V. I. Kuzmin in 1938–1939. Most of the species of *Potamogeton* collected by B. W. Skvortzow were identified by Prof. V. L. Komarov of Leningrad, USSR, in 1930, and several by Dr. M. Kitagawa of Hsinking, Manchoukuo, in 1938.

Our present contribution contains the description of 14 species of *Potamogeton,* and the following features are pointed out in connection with the *Potamogeton* flora of northern Manchuria; (*a*) 50 per cent of all species here recorded are of cosmopolitan nature; they are: *Potamogeton pectinatus* Linn., *P. crispus* Linn., *P. pusillus* Linn., *P. natans* Linn., *P. heterophyllus* Schreb., *P. lucens* Linn., and *P. prælongus* Wulf. (*b*) The remaining species are Oriental plants, as *Potamogeton Maackianus* A. Benn. and *P. oxyphyllus* Miquel, reported from Manchuria, China, and Ussuri, USSR; and *P. Vaseyi* Robbins, *P. Tepperi* A. Benn., and *P. malainus* Miquel, known from Manchuria, Japan, China, Korea, the Philippines, and India. Only 2 species, *Potamogeton manschuriensis* A. Benn. and *P. perfoliatus* Linn. var. *mandschuriensis* A. Benn., are endemic to Manchuria. (*c*) *Potamogeton pectinatus* Linn. var. *gracilis* var. nov. and *P. malainus* Miquel var. *terrestris* var. nov. are proposed as new. (*d*) *Potamogeton crispus* Linn. × *P. Maackianus* A. Benn., a new hybrid, is proposed.

All *Potamogeton* species here described are illustrated by the authors. The diagrams have been made with E. Leitz Nos. 0, 1, 3, and 6 drawing oculars, and Nos. 1, 2, and 4 objectives.

Subgenus CALEOGETON (Reichb.) Raunk

Section CONVOLUTI Hagstr.

1. POTAMOGETON PECTINATUS LINNÆUS. Plate 13.

Potamogeton pectinatus LINNÆUS in Komarov, Flora USSR 1 (1934) 239, *pl. 12, figs. 4a–c.*

Rhizoma longa, ramosa, alba, repens, 2 mm diametro. Hibernacula tuberosa, ovaliformis, acuminata, 0.7 ad 5 cm longa, squamis vestitos edens. Caulis 50 ad 110 cm longus, tenuis, filiformis, rigidas, parte basalis simplex, rarissime ramosus, parte terminalis zigzagiformis ramosus et dense foliosus. Internodis inferiora 5 ad 11 cm, suprema 0.5 ad 2 cm longa. Folia tota demerso vaginalis filiformis 2 ad 7 cm longa, 0.3 ad 0.5 mm lata, atrovirens squarrosa. Folia novella apice acuminata vel modice apiculata, folia adulta apice abrupte subrostrata vel capitata. Vagina foliae distincta, 1 ad 3 cm longa, viridia, lata cum ligula acuminata membranacea ca. 0.2 ad 0.5 mm longa. Venis tota 3, centralis distinctis, margine tenuis indistinctis, venis lateralis sub angulo 90° divergentes. Pediculis racemi longis, filiformis, tenuis 5 ad 7 cm longis. Racemi pauciflori elongati, 2 ad 3.5 cm longi. Flores 1.5 ad 2 mm diametro, petalum accessorius androeci 1 mm latum, rotundatum. Racemus fructiferus elongata cum 5 ad 15 fructis laxis. Fructus robustis, 5 ad 7 mm longis, 2 ad 2.5 mm lata rotundato-ovalis depressis, ventralis rotundatis valde undulatis, dorsalis inflato sensum undulatis et costatis, in fronte elliptico-ovalis, a tergo subrotundatis cum stigma fere centralis. Stigma stipiformis adunca adversa.

MANCHURIA, Pinchiang Province, in lake near Cheng, August 20, 1924, *B. W. Skvortzow:* Kirin Province, in lake near Taolaichao, Sungari valley, August 10, 1927, *B. W. Skvortzow;* in lake Harbin, July 19, 1938, *V. I. Kuzmin;* in stagnant lake of Ashiho valley, August 14, 1939, *V. I. Kuzmin;* in lake of Sungari valley, August 21 and October 17, 1939, *B. W. Skvortzow.*

Distribution.—Europe, America, Siberia, Kamchatka, China, Japan, Korea, Manchuria.

2. POTAMOGETON PECTINATUS Linn. var. GRACILIS Kuzmin and Skvortzow var. nov. Plate 12, figs. 7 to 10.

Caulis parte basalis simplex pauciramosus, ramis lateralibus instructi-erecti vel adscendentes parte terminalis dense ramosi

et foliati. Basalis 0.8 mm, terminalis, 0.1 ad 0.15 ad 0.17 mm diametro. Internodiis basalis, 5 ad 7 (ad 11) cm longis, terminalis, 2, 3, 6 (ad 8) mm longis. Foliis capilliformis aut hispidiformis, 2, 4, 5 (ad 6) cm longis, 0.16 ad 0.18 ad 0.25 mm latis, atrovirens, novella et adulta tota sensim acuminatis, ad apex cum venis indistinctis, in parte axilaris cum una venis centralis et venis lateralis sub angulo 90° divergentis. Vagina foliae 3 ad 6 ad 8 (ad 12) mm longa viridia. Ligula 0.5 ad 0.8 mm longa, acuminata. Flores et fructus ignota. Differt a typum foliis et caulis angustioribus.

MANCHURIA, Pinchiang Province, in stagnant lake near Harbin, Sungari valley, July 10, 1925, *B. W. Skvortzow.*

Potamogeton pectinatus Linn. is one of the commonest species in large lakes along Sungari River near Harbin. This plant constitutes thick growths especially in August and September. The new variety here described was classified by Prof. V. Komarov as *Potamogeton filiformis* Pers.

Subgenus EUPOTAMOGETON Raunk

Section ADNATI Hagstr.

3. POTAMOGETON MAACKIANUS A. Bennett. Plate 1, figs. 1 to 13.

Potamogeton maackianus A. BENNETT in Komarov, Flora USSR 1 (1934) 240, *pl. 12, figs. 5a–b.*

Rhizoma abbreviata, nodosa, fulvo-pubescens, filiforma, cum radicis gracilis brunnescens. Caulis gracilis, 0.3 ad 0.7 mm diametro, 20 ad 100 cm longis rigidis, diffusis vel dense ramosis ad parte terminalis. Internodis suprema 1 ad 3 (ad 4) cm, inferiora 3 ad 12 cm longa. Folia tota demerso viridia, 2 ad 4 (ad 7) cm longa, 2 ad 3 mm lata, lineari cum marginis parallelis sessilis, basin sensum attenuata late angustata vaginata. Vaginula viridia brevia 3 ad 4 cm longa. Folia novella ligula acuminata, 0.5 ad 1 cm longa, adulta cum ligula divisa corymbosa. Apex foliae rostrata rotundata aut emarginata. Margine minute denticulata, basi remota, ad apex conferta et manifesta. Venis tota 5, primaris ad parte mediana connata, ad apex monovenis. Venis secundaris parallelis, margine venis saepe undulatis et ad media foliae rare preruptis. Pediculis racemi elongatis, filiformis, 2 ad 3 (ad 4) cm longis. Racemi cylindricus, pauciflori 1.3 ad 2 cm longis, cum 3 ad 4 (ad 8) fructus laxus. Flores ignota. Fructus 2 ad 3 mm diametro, fere rotundato-depressus, dorsalis 3-undulato-emarginatus triquetro-costatus ventralis rotundatus, lateribus compressus, superne

ovatus, in fronte viza rotundatus, a tergo rostratus. Stigma stipiformis elongata ad media parte fructus dispositis. Embryo involutus.

Differt a typus foliis vaginalis et ligularis.

MANCHURIA, Pinchiang, in fresh-water lake near Cheng, July 12, 1924, *B. W. Skvortzow;* in lake near Harbin, July 19, 1938, *V. I. Kuzmin;* in lake near Huangchan, Ashiho valley, September 9, 1939, *B. W. Skvortzow;* in Lake Chingpeho, October 10, 1931, *A. S. Lukachkin.*

Distribution.—Manchuria, Japan, China, Ussuri, Kamchatka.

Fairly common near Harbin in small *Zizania* lakes and bogs. The plant collected near Cheng was identified by Prof. V. Komarov. The hybrid, *P. crispus* × *P. Maackanus,* was observed near Acho, eastern Harbin.

Section BATRASHOSERIS Irmisch

4. POTAMAGETON CRISPUS Linnæus. Plate 2, figs. 1, 4, and 5; Plate 3, figs. 1 to 11.

Potamogeton crispus LINNÆUS in Komarov, Flora USSR 1 (1934) 240, 241, *pl. 12, figs. 6a, b.*

Rhizoma tenuis ramosa, 1 mm diametro. Caulis complanatus, alatus, 1 ad 2.2 mm diametro, 80 ad 100 cm longus, parte terminalis dense ramosus. Internodis suprema 3 ad 4 (ad 5) cm, inferiora 2 ad 2.5 (ad 3.5) cm longa, ad caulis secundaris 1 ad 1.5 cm longa. Folia omnia equaliter lineari-lanceolata vel lanceolata, 1.7 ad 3 (ad 4.5) cm longa, 0.3 ad 0.5 (ad 0.8) mm lata, coriacea membranacea olivacea-viridia, crispae denticulata, apice rotundato vel abrupto-acuminata, basi attenuata vel rotundata. Venis primaris crassis, secundaris 2 ad 4 filiformis, lateralis sub angulo 80° ad 90° divergentes. Stipulae 1 ad 2 mm longae, latae, fuscae. Pediculis racemi 3 ad 3.5 (ad 4) cm longa, tenua non incrassata. Racemi pauciflori, 7 ad 12 mm longis. Fructis robustis, confertis adhaerens parte basalis 2.5 ad 3 mm longis, ovalis, depressis, dorsalis rotundato-undulatis ud costatis. Stigma curvata elongata falcata.

MANCHURIA, Lungchiang Province, along banks of streams near Tsitsihar, June 18, 1924, *B. W. Skvortzow.*

Distribution.—Europe, Siberia, Turkestan, Africa, America, Australia, Japan, Manchuria.

5. POTAMOGETON CRISPUS var. SERRULATUS Reichenbach. Plate 2, figs. 2 and 7.

Potamogeton crispus var. *serrulatus* REICHENBACH in Hegi, Illust. Flora v. Mittel-Europa 1 (1906) 132.

Potamogeton crispus LINNÆUS (*P. serrulatus* Schrd.) in Komarov, Flora USSR 1 (1934) 240.

Folia lineari-lanceolata, 4 ad 6 (ad 7) cm longa, 3 ad 7 mm lata, plana, denticulata non crispa, apice attenuato-rotundata, basi rotundata leviter attenuata. Flores non vidi.

MANCHURIA, Pinchiang Province, on banks of streams near Acho, Mudangchiang valley, July 20, 1924, *B. W. Skvortzow.*

POTAMOGETON CRISPUS Linnæus × POTAMAGETON MAACKINUS A. Bennett. Plate 1, figs, 14 and 15; Plate 2, figs. 3, 6, 8, and 9.

Rhizoma brevis, polyrrhiza. Caulis 50 cm longa, parte terminalis cum ramulis abbreviatis. Folia tota demerse viridia, 2 ad 4 ad 5 (ad 7) cm longa, 2.5 ad 4 cm lata, sessilia, linearia, apice breviter acuminata, rotundata aut rostrata, margine distincte denticulata. Venis tota 5. Nervi lateralis sub angulo 80° ad 90° divergentes. Foliis vagina et ligula evolutis. Flores et fructus non vidi.

MANCHURIA, Pinchiang Province, in mountain streams near Acho, Mutangchiang valley, July 20, 1924, *B. W. Skvortzow.*

This plant was identified by V. Komarov as *Potamogeton graminea* × *P. Maackianus,* but it seems to be *P. crispus* × *P. Maackianus.*

Section COMPRESSI Koch

6. POTAMOGETON MANSCHURIENSIS A. Bennett. Plate 4, figs. 6 to 14.

Potamogeton manschuriensis A. BENNETT in Komarov, Flora USSR 1 (1936) 243./

Rhizoma ignota. Caulis 40 ad 60 cm longa, complanatus tenuis 0.8 ad 1 mm diametro, ad parte basalis simplex, ad parte terminalis ramosus. Internodis 1 ad 6 (ad 10) cm longa, ad parte terminalis abbreviata. Folia attenuato-linearia, 2 ad 6 ad 9 (ad 11) cm longa, 0.5 ad 1 ad 2 (ad 3) mm lata, sessilis, viridia, integerrima basin non attenuata. Folia novella filiformia-acuminata cum 1 venis primaris ud 6 venis lateralis tenuis. Folia adulta sensum acuminata vel apiculata vel cuneata cum 1 venis primariis ud 12 ad 16 venis lateralis. Stipulae 1 ad 2 cm longae, acuminatae, dilute argillacea deciduus. Pediculis racemi 1.5 ad 3.5 cm longa, tenua 1 mm diametro non incrassatus. Racemi cum 6 ad 12 flores 5 ad 7 mm longa, fructifera 0.8 ad 1 cm longa et 0.5 mm lata. Flores 1.2 ad 1.3 mm diametro. Petalum accessorius androeci reniformis viridia cum venis indistinctis fere 1 mm lata. Fructus 2.5 ad 3 mm longa, obovato-rotundata, depressa, ventralis inferiora

nodosa, dorsalis rotundata undulata et costata. Embryo involuto. Stigma incurvata ut capitata. Differt a typum fructus parte ventralis nodosa.

MANCHURIA, Pinchiang Province, in stagnant lakes near Harbin, Metaitzu, Sungari valley, July 10, 1925, *B. W. Skvortzow.*

Distribution.—Ussuri (USSR), Zea-Burea, Manchuria.

Only one lake was found rich in this distinct species associated with *Potamogeton pusillus, P. Vaseyi,* and *Euryale ferox.*

7. POTAMOGETON OXYPHYLLUS Miquel. Plate 12, figs. 1 to 6.

Potamogeton oxyphyllus MIQUEL in Komarov, Flora USSR 1 (1934) 243, 244, *pl. 12. fig. 9.*

Caulis valde complanatus ramosus, 0.3 mm diametro. Internodis 2 ad 6 ad 9 (ad 12) cm longa ad parte terminalis abbreviatis. Nodis valde apertus fuscentes. Folia 2 ad 4.5 (ad 6) cm longa et 0.4 ad 0.5 mm lata, linearis sessilis, ad basin valde tenuata, ad apicem sensim acuminata asymmetricis integerrimis. Venis primariis robusta cum venis lateralis parallelis connata, venis lateralis 6 ad 8, venis marginalis indistinctis. Stipulae 0.5 ad 1 cm longae, elongatae membranacea viridiae, adulta fuscentes decideus. Flores et fructus ignota.

MANCHURIA, Pinchiang, in stagnant lakes near Cheng, September 10, 1925, *B. W. Skvortzow.*

Distribution.—Eastern Siberia, Ussuri; Japan; Korea, Manchuria.

8. POTAMOGETON PUSILLUS Linnæus. Plate 4, figs. 1 to 5, and 15 to 22.

Potamogeton pusillus LINNÆUS in Komarov, Flora USSR 1 (1934) 247, *pl. 12, fig. 15.*

Rhizoma tenuis saepe abortinus. Caulis 5 ad 20 ad 40 ad 60 cm longa, filiformis, 0.4 ad 0.5 mm diametro tubulosus ad parte terminalis dense ramosus cum internodis 1 ad 4 ad 5 (ad 6) cm longa. Folia linearis, 1 ad 4 (ad 6) cm longa, 1 ad 1.2 mm lata ad apicem sensim acuminata vel apiculata vel cuneata. Venis 3, primaris robustis et distinctis, lateralis filiformis. Folia novella venis indistinctis. Stipulae 0.5 ad 1 cm longae, membranaceae, argillaceae. Pediculis racemi filiformis, tenua 1 ad 3 cm longa. Racemus floriferus 3 ad 5 mm longa cum 5 ad 15 flores. Flores 1.5 ad 2 mm diametro. Fructus 2 mm diametro, rotundato-ovalis depressa, dorsalis rotundato leniter undulato-costata, ventralis angularis. Stigma curta ut lata, in fronte lageniformis, a tergo ovato triquetra.

MANCHURIA, Pinchiang Province, near Harbin, Metaitzu, Sungari valley, on banks of streams, July 27, 1923, and September

3, 1938, *B. W. Skvortzow;* Acho, Mutangchiang valley, on banks of streams, July 20, 1924, *B. W. Skvortzow;* near Ertientziantze, on banks of stagnant streams, July 5, 1927, *B. W. Skvortzow;* Ashiho valley, August 16, 1938, *V. I. Kuzmin.*

Distribution.—Europe; America; Asia, Eastern Siberia, Ussuri, Manchuria, Sakhalin, Japan, China, Korea.

One of the commonest species of *Potamogeton* near Harbin, growing in bogs, *Typha* ponds, and rice fields. Identified by Prof. V. Komarov from specimens collected near Harbin.

Section HETEROPHYLLI Koch

9. POTAMOGETON VASEYI Robbins. Plate 5, figs. 1 to 7; Plate 6, figs. 1 to 21.

Potamogeton Vaseyi Robbins in Kitagawa, M. Lineamenta Florae Manshuricae (1939) 54.

Potamogeton miduhikimo Makino in Komarov, Flora USSR 1 (1934) 252.

Rhizoma et radicea filiformis saepe ad nodis percurrentes. Caulis 30 ad 50 cm longa, filiformis 0.5 mm diametro, parte basalis simplex, parte terminalis ramosus et dense foliosus. Internodis 1.3 ad 6 cm longa. Folia dubia natans ud demerse. Folia demerso angusto-linearis elongatis 2 ad 4.5 (ad 6) cm longa, 0.4 ad 1 mm lata, plana filiformis viridia, apice acuminata vel apiculata, basi attenuata. Stipulae longae viridia fusco-lucidus 0.4 ad 5 cm longae, venis tota 3. Folia natantes elliptica aut elongata aut lanceolata, marginibus parallelis, plerumque versus basin et apicem aequaliter attenuata vel truncata aut cuneata, 1.8 ad 2.1 ad 3 ad 4 cm longa, 1.7 ad 2.2 ad 4 ad 6 mm lata, compacta cum 3 ad 5 ad 7 venis, venis marginalis tenuis indistinctis. Petioli tenui, 0.5 ad 1 ad 2 cm longa. Stipulae foliis natantes ud bracteae inflorescentiae magnae, latae, membranaceae, apice subacutae ut rotundatae, 1 ad 1.4 cm longae, 2 mm lata cum 2 venis primariis. Pediculis racemi 1.3 ad 2 cm longa, incrassatis 1 mm diametro. Racemi 0.5 ad 0.7 ad 1 cm longa, 2 ad 2.5 mm lata, cum 3 ad 5 ad 15 floribus. Flores 1.5 mm diametro, petalum accesorius androeci reniformis. Fructus 1.8 ad 2 mm diametro rotundato-ovata depressa, concava cum stigma stipiformis recta aut adversa. Dorsalis late rotundata costatis, dorsalis gibbosa, in fronte lageniformis, a tergo elongato-ovalis.

Manchuria, Pinchiang Province, in lakes near Cheng, July 7, 1936, *B. W. Skvortzow;* in lakes near Harbin, August 10, 1928, *B. W. Skvortzow,* June 29, 1938, *V. I. Kuzmin;* in lakes of Sungari valley, September 5, 1939, *B. W. Skvortzow.*

Distribution.—Siberia, Ussuri, Manchuria; Japan; Korea.

An interesting species with polymorph leaves, quite common near Harbin in the early part of summer.

10. POTAMOGETON TEPPERI A. Bennett. Plate 7.

Potamogeton tepperi A. BENNETT in Kitagawa, M. Lineamenta Florae Manshuricae (1939) 53.

Potamogeton diginus WALL. in Komarov, Flora USSR 1 (1934) 253, 254.

Rhizoma ignota. Caulis apice ramosis, 20 ad 45 cm longa, 1 ad 1.5 mm lata. Internodis 3 ad 5 ad 6 (ad 8) cm longa. Folia dubia natans ut demersa. Folia demerso lanceolata falcata, apice asymmetricis acuminata olivacea equaliter attenuata, fere plana vel subundulata, 4 ad 6 ad 10 (ad 14) cm longa, 0.8 ad 1 ad 1.5 cm lata. Venis primaris robustis latis, secundaris 10 ad 16 tenuis. Petioli 1 ad 3 ad 5 ad 6 (7.5) cm longa. Folia natantes compactus coriaceus lucens, 2.5 ad 3 ad 5 ad 6 (ad 7) cm longa, 2 ad 3 cm lata, ovalis lanceolata vel elliptica, equaliter attenuata, apice abrupte acuminata, supra olivacea vel viridia, subtus rubra. Venis primaris distincta, secundaris 16. Petioli 8 ad 10 ad 12.9 ad 15 cm longa. Stipulae 4 ad 5 ad 6 cm longae, late-acuminatae, deciduae. Pediculis racemi incrassatus, 4 ad 6 (ad 7) cm longa. Racemi 2 ad 3 ad 4 cm longa, multiflori. Flores 1.5 to 2 cm diametro, digynus. Fructus 2.5 mm diametro, dorsalis rotundata costata, ventralis lata, in fronte quadrata, a tergo sexangulata. Stigma curta.

MANCHURIA, Pinchiang Province, on banks of streams near Acho, Mutangchiang valley, August 10, 1930, *B. W. Skvortzow.*

Distribution.—Reported from Siberia, Ussuri, Manchuria; Japan; China; India; Philippines.

11. POTAMOGETON NATANS Linnæus. Plate 12, fig. 11.

Potamogeton natans LINNÆUS in Komarov, Flora USSR 1 (1934) *pl. 12, fig. 21a, b.*

Caulis 40 ad 50 cm longa, 1.5 mm diametro, parte terminalis ramosus. Folia natans elliptica, ovala, subovala aut elongata, 6 ad 8 (ad 11) cm longa, 2.5 ad 3.5 cm lata, arillata, basi attenuata vel rotundata, apice abrupta acuminata utrinque viridia. Venis 20 ad 21 distinctis. Stipulae 6 ad 8 cm longae, viridiae. Flores non vidi.

MANCHURIA, Pinchiang Province, in lakes near Jablonaia, August 20, 1925, *B. W. Skvortzow.*

Distribution.—Europe; Asia, Manchuria; America; Africa.

12. POTAMOGETON HETEROPHYLLUS Schreb. Plate 14, fig. 9.

Potamogeton graminea Linn. var. *heterophyllus* FRIES in Komarov, Alisova-Klobukova, Key for the Plants of the Far Eastern Region of the USSR (1931) 132, *pl. 29, figs. 6–10.*

Potamogeton heterophyllus SCHREB. in Komarov, Flora USSR 1 (1934) 256, *pl. 12, fig. 22a–c.*

Rhizoma crassa ramosa 1 ad 1.5 mm diametro. Caulis 40 ad 80 cm longa, subtiliter ramosa crassa, 2 mm diametro. Internodis 2 ad 5 ad 8 (ad 10) cm longa. Folia 7 ad 15 (ad 17) cm longa, 0.5 ad 1 cm lata lanceolata equaliter attenuata, ad apicem saepe arcuato-acuminata, integerrima plana obscura-viridia. Venis primaris 1, lateralis 6. Stipulae 2 ad 4 cm longae elongatae viridiae. Flores non vidi.

MANCHURIA, Pinchiang Province, on banks of streams near Hsiaoling, July 20, 1938, *B. W. Skvortzow.*

Distribution.—Europe, Siberia, North America, Japan, Manchuria.

13. POTAMOGETON LUCENS Linnæus. Plate 8, figs. 1 to 9; Plate 9, figs. 1 to 16.

Potamogeton lucens LINNÆUS in Komarov, Flora USSR 1 (1934) 257, 258, *pl. 12, fig. 23a-c.*

Rhizoma elongata, crassa, 3 mm diametro, albida. Caulis 40 ad 90 cm longa, ad parte terminalis dense ramosi. Internodis suprema 1.3 ad 5 cm, inferiora 10 ad 26 cm longa. Folia tota demerso, (3) 4 ad 8 (ad 13) cm longa, 1.5 ad 2.3 cm lata viridis membranacea, suprema folio elongato-elliptica, abrupto-rotundata cum spinis terminalis 1 mm longa, inferiora lanceolata-elongata, acuminata cum spinis 1 ad 3 cm longa. Folia novella margine minute serrulata leniter undulata. Costa distincta lata ad basin impresse dilatata, secundaris utrinque 6 a costa sub angulo 15° ad 20° divergentes, venis marginalis tenuissima. Folia in petioles brevissimus, ca. 1 cm longa. Stipulae ut bracteae inflorescentiae 1.5 ad 5.5 cm longae, robustae lanceolatae, membranaceae-viridia plus minusve squarrosae, saepe tubulosae, cum 2 costae et venis secundaris multinervis, apicem rotundatae. Pediculis raceme crassis robustis, ca. 4 ad 5 cm longis. Racemi cylindricis multiflori, 2 ad 4 cm longa. Flores 2 ad 2.5 mm in diametro, petalum accessorius and roeci 1 ad 1.5 mm latus reniformis cum venis indistinctis. Fructus 2 ad 2.5 mm diametro fere rotundato-depressa, dorsalis rotundatis accrescens et apertus cum marginibus fere undulatis ut 3 costatis, ventralis fere plana, superne ovato, in fronte elongato-rotundato, a tergo acutangularis. Stigma stipiformis alaris. Embryo involuta.

MANCHURIA, Pinchiang Province, in fresh-water lakes, Ashiho valley near Huangshan, September 10, 1939, *V. I. Kuzmin.*

Distribution.—Europe, Kaukasus, Siberia, North America, Manchuria. Reported by Litvinov from environs of Tsitihar.

14. POTAMOGETON MALAINUS Miquel. Plate 10, figs. 1 to 3 and 5 to 9; Plate 11, figs. 1 to 22.

Potamogeton malainus MIQUEL in Komarov, Flora USSR 1 (1934) 258, 259, *pl. 12, fig. 24a, c.*

Rhizoma tenua repens. Caulis simplex solitarius rarissime ramosus, 100 ad 170 cm altus, cum ramulis abbreviatis, sub nodo interdem radicalis. Internodis suprema 4 ad 7 ad 10 cm, inferiora 15 ad 18 cm longis. Folia omnio demerso viridia olivacea, 5 ad 8 ad 19 cm longa, 1.8 ad 2 ad 3 cm lata, membranacea late linearia vel anguste-linearia, subovato-oblonga vel ovato-lanceolata, abrupta cum spinis 2 ad 3 mm longa ornata, basi rotundata vel late cuneata, margine minute subundulata-crispa, leviter denticulata. Venis primaris robustis, secundaris 3 ad 4 ad 5 distincte prominulis, margine venis tenuis indistinctis. Folia demerso longe petiolata, 2 ad 6 ad 11.5 cm longa superiora dilatada. Stipulae ut bracteae inflorescentie magnae ca. 4 ad 7 cm longae acuta lanceolata membranacea viridia olivacea cum 2 venis primariis. Pediculis racemi elongatis robustis crassis, 5 ad 6.5 cm longa. Racemi cylindricis multiflori 3 ad 4 cm longa. Flores 4 ad 5 mm diametro. Petalum accesorius androeci reniformis 1 mm latus cum venis tenuis indistinctis. Fructus ca. 2.5 ad 3 cm diametro adversus rotundo-obovata vel ovata, dorsalis undulata emarginata triquetro angulata, ventralis levissima arcuata ut angulata, lateribus compressa, superne rotundato-ovata vel subovata, in fronte acuminato-rotundata, a tergo undulata. Stigma stipiformis lateribus brevis. Embryo involuta. Differt a typum foliis latissimis ut fructus robustris.

MANCHURIA, Pinchiang Province, Sungari valley, near Metaitzu, August 23, 1939, *B. W. Skvortzow,* September 20, 1939, *V. I. Kuzmin.*

Distribution.—Eastern Siberia, Ussuri; Korea; Japan; China; Manchuria; India; Borneo; Java; Philippines.

15. POTAMOGETON MALAINUS Miquel var. TERRESTRIS Kuzmin and Skvortzow var. nov. Plate 10, fig. 4; Plate 11, fig. 23.

Planta terrestris cum caulis simplex, rarissime ramosa, cum internodis confertus et folius minoris. Folia terrestris 3.5 ad 6 ad 7.5 cm longa, 1 ad 2 ad 2.5 cm lata, compacta viridia vel

rubra, elliptica, elliptico-elongata abrupta, cum spina apicalis 1 mm longa. Margine integerrima subundulata fere plana. Venis primaris brunnea vel rubra, secundaris, 4 ad 5. Flores non vidi.

MANCHURIA, Pinchiang Province, in humid meadows of Sungari valley, July 7, 1938, *B. W. Skvortzow;* on banks of streams near Harbin, September 20, 1939, *B. W. Skvortzow.*

Section PELTOPSIS Rouy

16. POTAMOGETON PRAELONGUS Wulf. Plate 14, fig. 8.

Potamogeton praelongus WULF in Komarov, Flora USSR 1 (1934) 259, *pl. 12, figs. 25a, b.*

Rhizoma ramosa. Caulis 40 ad 60 cm longa, 1 mm diametro. Internodis 2 ad 6 ad 8 cm longa, parte terminalis abbreviata. Folia 8 ad 10 ad 15.9 ad 17 cm longa, 0.8 ad 1 ad 1.2 cm lata attenuato-lanceolata, sessilis margine subundulato-crispa non denticulata olivacea amplexicaule, apice abrupto acuminato. Venis primaris distinctis crassa, secundaris 8. Stipulae 1 ad 1.5 cm longae, indistinctis. Pediculis racemi 3 ad 5 ad 7 cm longa. Racemi cylindricis 8 ad 12 flore. Flores 1.5 mm diametro. Fructus non vidi.

MANCHURIA, Pinchiang Province, on banks of streams near Acho, Mutangchiang valley, July 20, 1924, *B. W. Skvortzow.*

Distribution.—Europe, North America, Siberia, Manchuria.

17. POTAMOGETON PERFOLIATUS Linn. var. MANDSCHURIENSIS A. Bennett. Plate 14, figs. 1 to 7.

Potamogeton perfoliatus Linn. var. *mandschuriensis* A. BENNETT in Komarov & Klobukova-Alisova, Key for the Plants of the Eastern Region of the USSR (1931) 131, *pl. 30, fig. 1.*

Potamogeton perfoliatus LINNÆUS in Komarov, Flora USSR 1 (1934) 260, *pl. 12, fig. 26a–c.*

Rhizoma ramosa. Caulis simplex vel ramosa 20 ad 45 ad 65 ad 100 cm longa cum internodis 0.5 ad 1 ad 2 ad 4 cm longa, apice abbreviata. Folia oblonga-ovala vel ovala, basi rotundata amplexicaulis, apice acuminata, margine undulata vel crispa 2 ad 2.5 ad 4.5 cm longa, 0.8 ad 1.5 ad 1.8 cm lata. Venis primaris 3, secundaris 5 ad 6 ad 8, lateralis sub angulo 80° divergentes. Stipulae 0.3 ad 0.5 cm longae. Pediculis racemi 1 ad 2 ad 3 cm longa, recta. Racemi 1 ad 2 cm longa, 8 ad 12 floriferi. Petalum accessorius androeci reniformis, 1.2 mm diametro. Fructus non vidi.

MANCHURIA, Lungchiang Province, on banks of streams near Tsitihar, June 18, 1924, *B. W. Skvortzow:* Pinchiang Province, in lakes of Chingpehu, November 10, 1931, *A. S. Lukachkin.*

Distribution.—Europe, Asia, North Africa, Central and North America, Australia.

We have no original description of var. *mandschuriensis* A. Benn. Judging from the type species the Manchurian plant differs by its elongate-crispate leaves.

ILLUSTRATIONS

Plate 1

Figs. 1 to 13. *Potamogeton Maackianus* A. Bennett. Fig. 1, upper part of plant with fruits; *2*, fruit, side view, enlarged; *figs. 3* and *4*, fruits, front view, enlarged; *fig. 5*, fruit, seen from above, enlarged; *6*, gross section of fruit with embryo inside, enlarged; *7*, vagina and ligula, enlarged; *figs. 8* and *9*, ligula, enlarged; *10* to *13*, end parts of leaves, enlarged.

14 and 15. *Potamogeton crispus* Linn. × *P. Maackianus* A. Bennett; end part of leaves, enlarged.

Plate 2

Fig. 1. *Potamogeton crispus* Linnæus; upper part of plant with unripe fruits and with a winter bud.

2. *Potamogeton crispus* Linn. var. *serrulatus* Reichenbach; upper part of a branch.

3. *Potamogeton crispus* Linn. × *P. Maackianus* A. Bennett; upper part of stem.

Figs. 4 and 5. *Potamogeton crispus* Linnæus; end part of leaves, enlarged.

Fig. 6. *Potamogeton crispus* Linn. × *P. Maackianus* A. Bennett; and part of leaf, enlarged.

7. *Potamogeton crispus* Linn. var. *serrulatus* Reichenbach; end part of leaves, enlarged.

Figs. 8 and 9. *Potamogeton crispus* Linn. × *P. Maackianus* A. Bennett; end part of leaf, enlarged.

Plate 3. Potamogeton crispus Linnæus.

Figs. 1 and 2, fruits, side view, enlarged; *3* and *4*, fruits, front view, enlarged; *fig. 5*, four fruits grown together, enlarged; *6*, cross section of fruit with embryo inside, enlarged; *7*, fruit, seen from above, enlarged; *figs. 8* and *9*, two types of stipules, enlarged; *10* and *11*, lower part of two leaves from a winter bud, enlarged.

Plate 4

Figs. 1 to 5. *Potamogeton pusillus* Linnæus. Fig. 1, upper part of a stem with flowers and fruits; *figs. 2* to *5*, end part of leaves, enlarged.

6 to 14. *Potamogeton mandschuriensis* A. Bennett. Fig. 6, upper part of stem with fruits; *figs. 7* to *10*, end part of leaves, enlarged; *fig. 11*, cross section of fruit with embryo inside, enlarged; *figs. 12* to *14*, fruit, side view, enlarged.

15 to 22. *Potamogeton pusillus* Linnæus. Figs. *15* to *17*, fruits, side view, enlarged; *8* and *19*, fruits, front view, enlarged; *20* to *22*, fruits, front view, enlarged.

PLATE 5. POTAMOGETON VASEYI ROBBINS.

FIG. 1. Upper part of plant with floating and submersed leaves, flowers, and fruits; *2*, flower, enlarged; *figs. 3* to *6*, different types of floating leaves, enlarged; *fig. 7*, stipule, enlarged.

PLATE 6. POTAMOGETON VASEYI ROBBINS.

FIGS. 1 and 2, parts of stem with stipules, enlarged; *3* and *4*, different types of floating leaves, enlarged; *5* to *7*, end part of submersed leaves, enlarged; *8* and *9*, petalous part of stamens, enlarged; *10* to *14*, fruits, side view, enlarged; *15* and *16*, ovaries, enlarged; *17* to *19*, fruits, seen from above, enlarged; *20* and *21*, fruits, front view, enlarged.

PLATE 7. POTAMOGETON TEPPERI A. BENNETT.

FIG. 1, upper part of plant with flowers and fruits; *2*, flower, enlarged; *figs. 3* and *4*, petalous part of stamens, enlarged; *fig. 5*, fruit, side view, enlarged; *6*, cross section of fruits with embryo inside, enlarged; *7*, fruit, seen from above, enlarged; *figs. 8* and *9*, fruit, front view, enlarged.

PLATE 8. POTAMOGETON LUCENS LINNÆUS.

FIG. 1, upper part of plant with flowers and fruits; *2*, flower, enlarged; *3*, end part of leaf, enlarged; *4*, submersed stem with distinct stipules; *5*, cross section of fruit with embryo inside, enlarged; *figs. 6* and *7*, stipules, enlarged; *8* and *9*, different types of leaves.

PLATE 9. POTAMOGETON LUCENS LINNÆUS.

FIGS. 1 to 4, petalous part of stamens, enlarged; *5* to *10*, fruits, side view, enlarged; *11* to *13*, fruits, front view, enlarged; *14* and *15*, fruits, front view, enlarged; *fig. 16*, end part of leaf, enlarged.

PLATE 10

FIGS. 1 to 3. *Potamogeton malainus* Miquel. Fig. 1, upper part of plant with flowers and fruits; *2*, ovary, enlarged; *3*, flowers, enlarged.

FIG. 4. *Potamogeton malainus* Miq. var. *terrestris* Kuzmin and Skvortzow var. nov.; small plant.

FIGS. 5 to 9. *Potamogeton malainus* Miquel. Fig. 5, stipule, enlarged; *figs. 6* to *8*, different types of leaves; *fig. 9*, end part of leaf, enlarged.

PLATE 11

FIGS. 1 to 22. *Potamogeton malainus* Miquel. Figs. *1* to *4*, petalous parts of stamens, enlarged; *5* to *12*, fruits, side view, enlarged; *13* to *16*, fruits, front view, enlarged; *17* to *20*, fruits, seen from above, enlarged; *21* and *22*, cross section of fruits with embryo inside, enlarged.

FIG. 23. *Potamogeton malainus* Miquel var. *terrestris* Kuzmin and Skvortzow var. nov.; end part of leaf.

PLATE 12

FIGS. 1 to 6. *Potamogeton oxyphyllus* Miquel. Fig. 1, upper part of plant; *2*, stipules, enlarged, *3*, middle part of leaf with veins, enlarged; *figs. 4* to *6*, end parts of leaves, enlarged.

7 to 10. *Potamogeton pectinatus* Linn. var. *gracilis* Kuzmin and Skvortzow var. nov. Fig 7, upper part of plant; *figs. 8* and *9*, end parts of leaves, enlarged; *fig. 10*, middle part of mature leaf, enlarged.

FIG. 11. *Potamogeton natans* Linnæus; upper part of stem.

PLATE 13. POTAMOGETON PECTINATUS LINNÆUS.

FIG. 1, upper part of plant with fruits; *2*, stipules and ligules, enlarged; *figs. 3* to *6*, fruits, side view, enlarged; *7* and *8*, fruits, front view, enlarged; *9* to *11*, fruits, seen from above, enlarged; *12* to *14*, petalous parts of stamens, enlarged; *15* to *17*, end parts of mature leaves, enlarged; *18* to *22*, end parts of young leaves, enlarged.

PLATE 14

FIGS. 1 to 7. *Potamogeton perfoliatus* Linn. var. *mandschuriensis* A. Bennett. Fig. 1, upper part of stem with flowers; *2*, part of inflorescence with flowers, enlarged; *figs. 3* to *5*, different types of leaves, enlarged; *6* and *7*, petalous parts of stamens, enlarged.

FIG. 8. *Potamogeton praelongus* Wulf; upper part of stem with flowers.

9. *Potamogeton heterophyllus* Schreb.; upper part of stem.

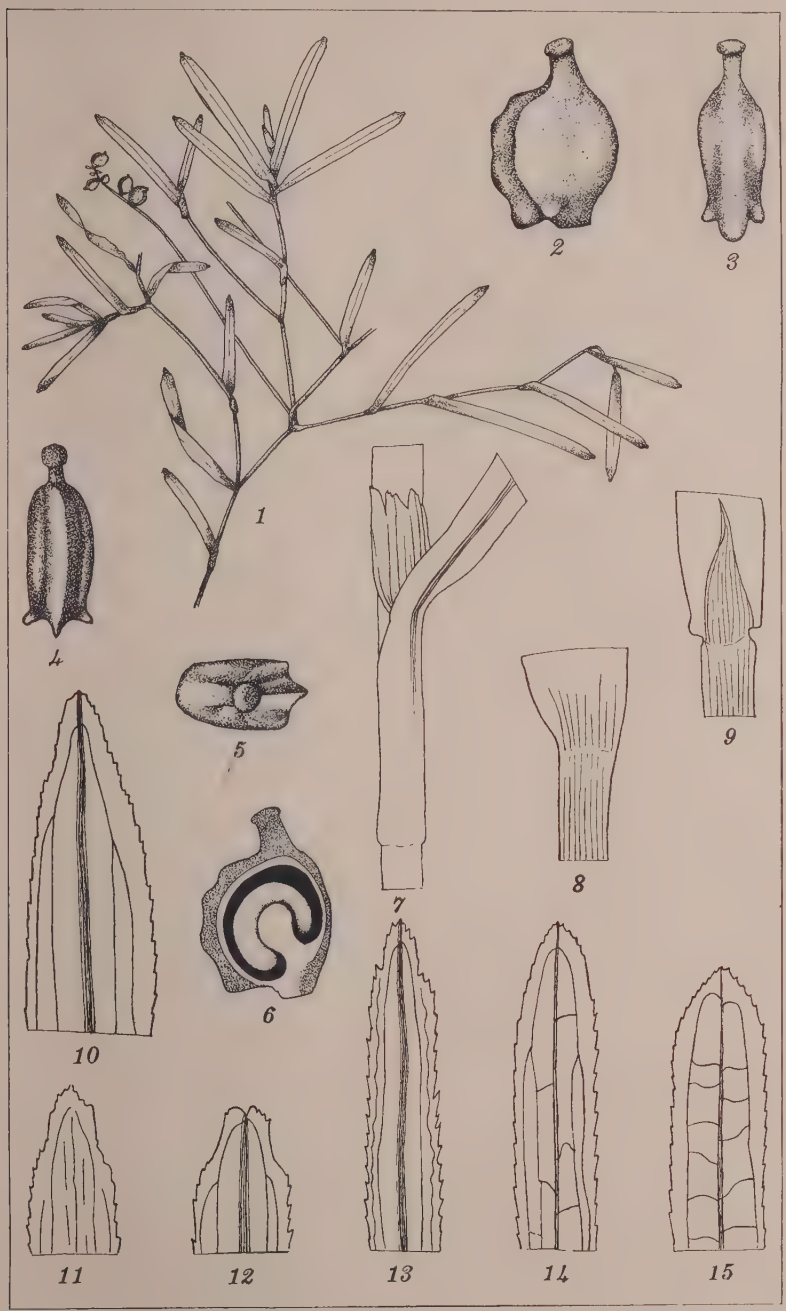


PLATE 1.

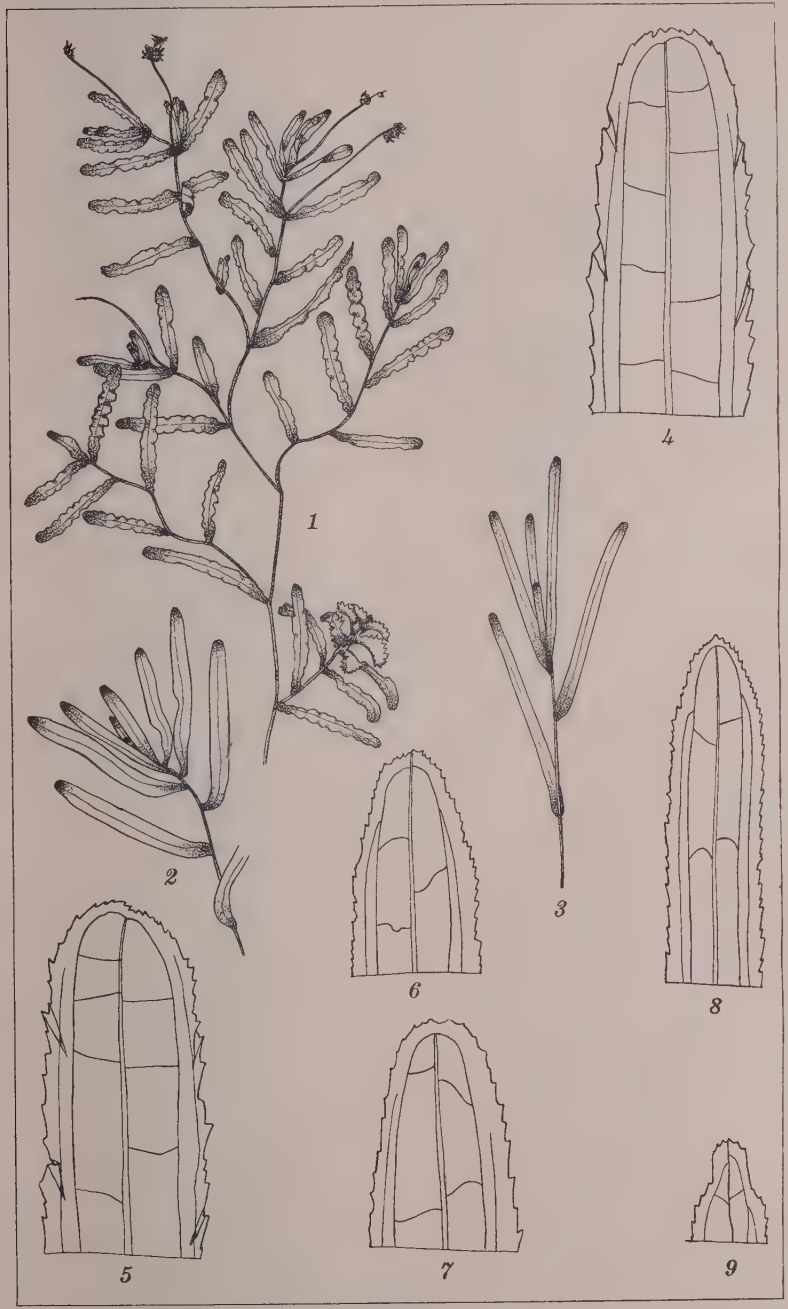
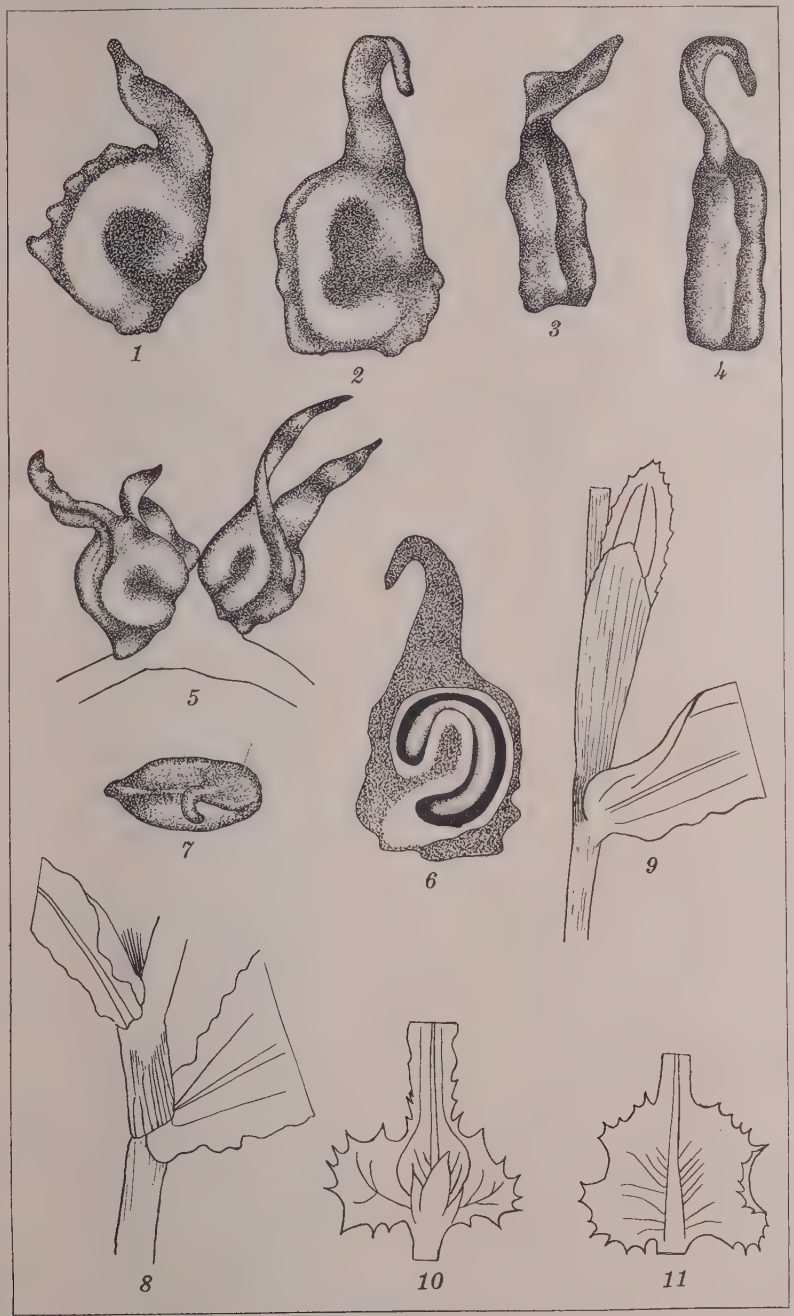


PLATE 2.



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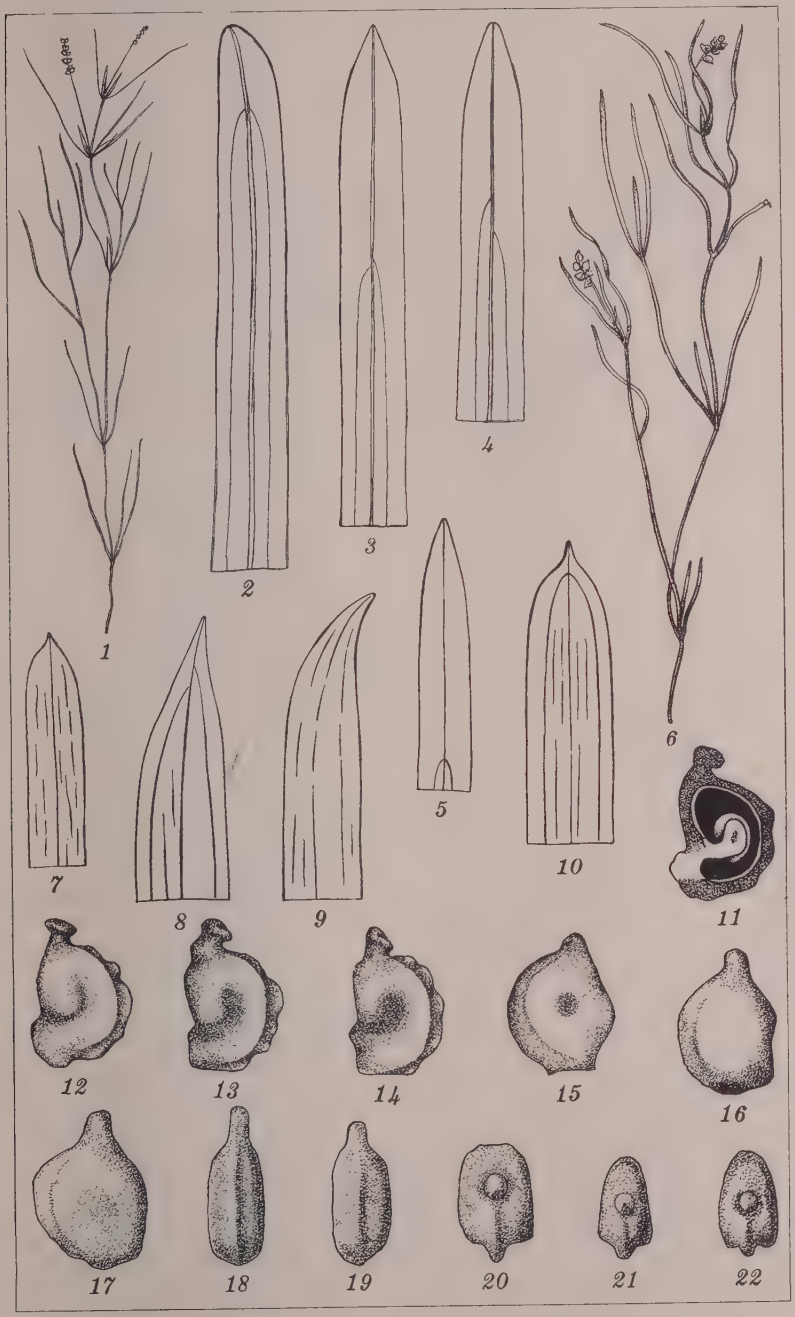

PLATE 4.

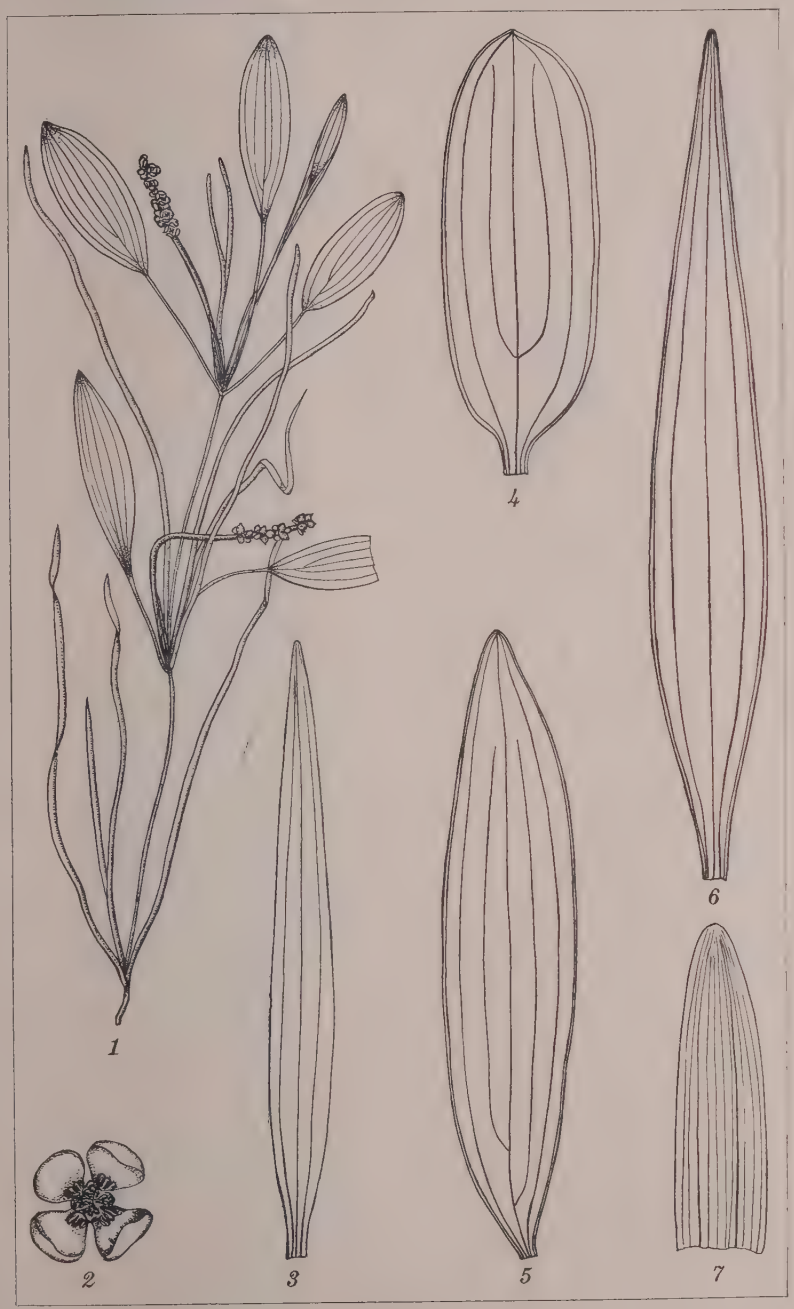

PLATE 5.

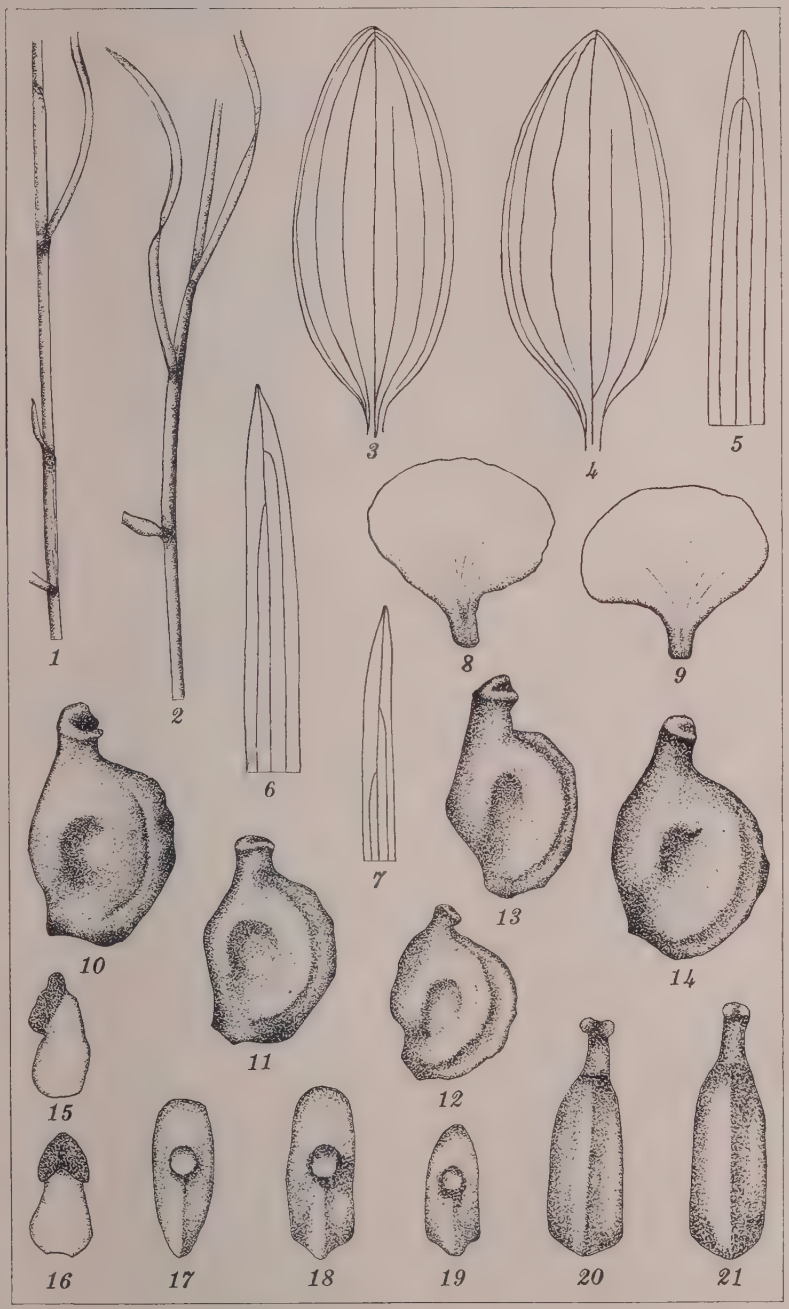

PLATE 6.

PLATE 7.

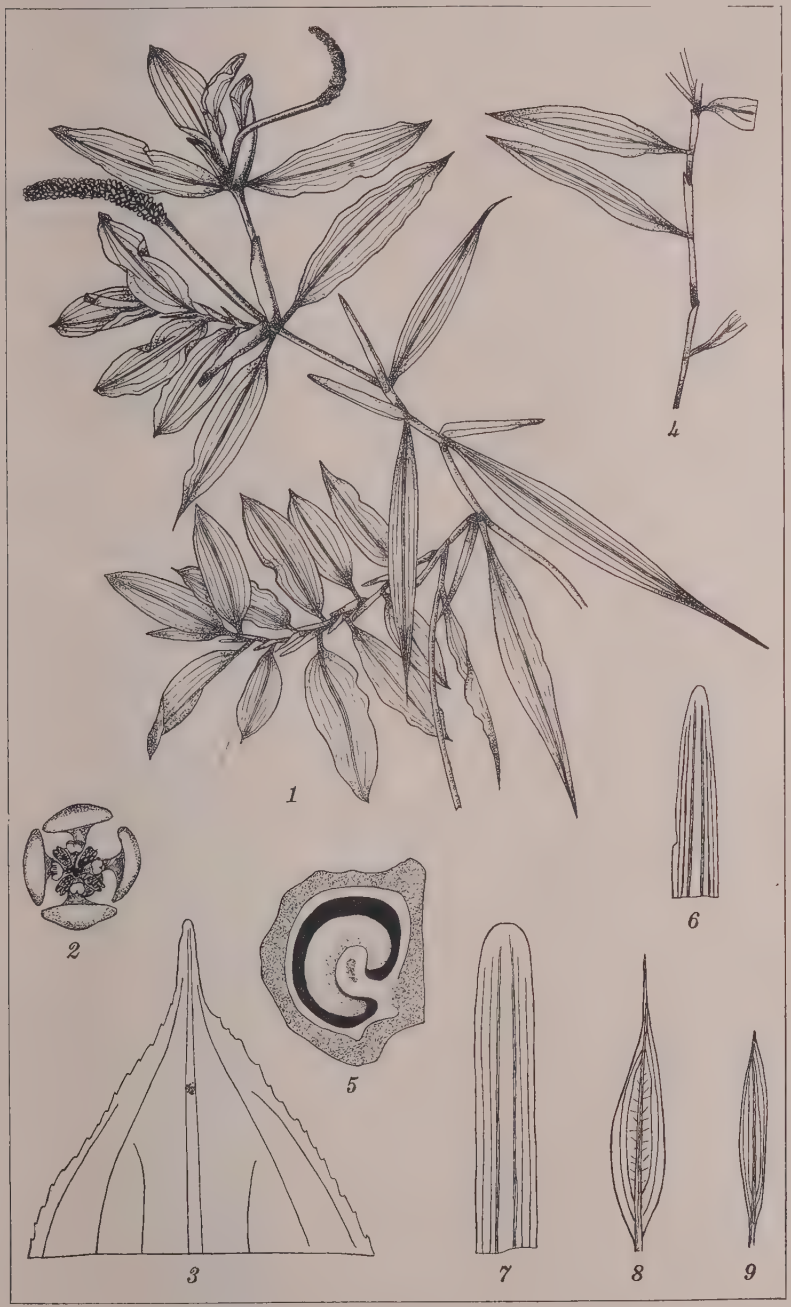

PLATE 8.

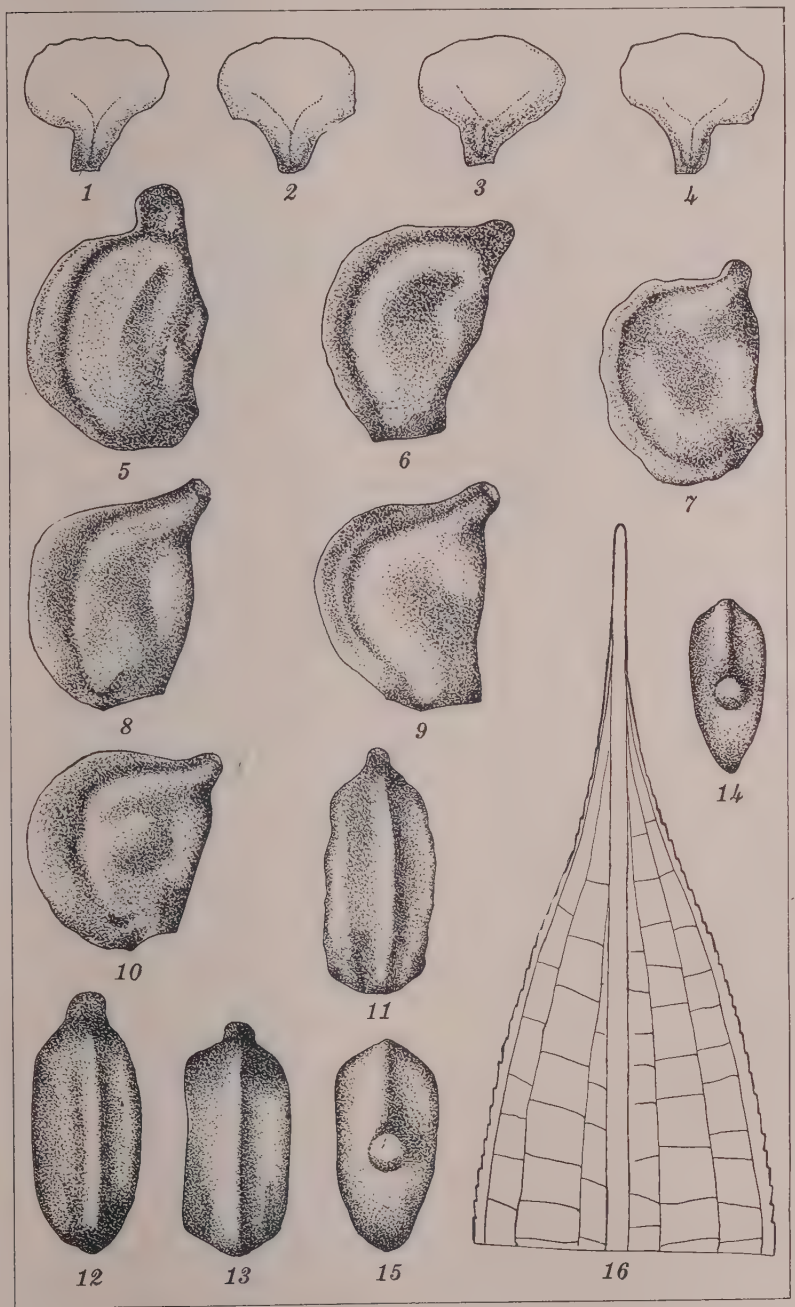

PLATE 9.

PLATE 10.

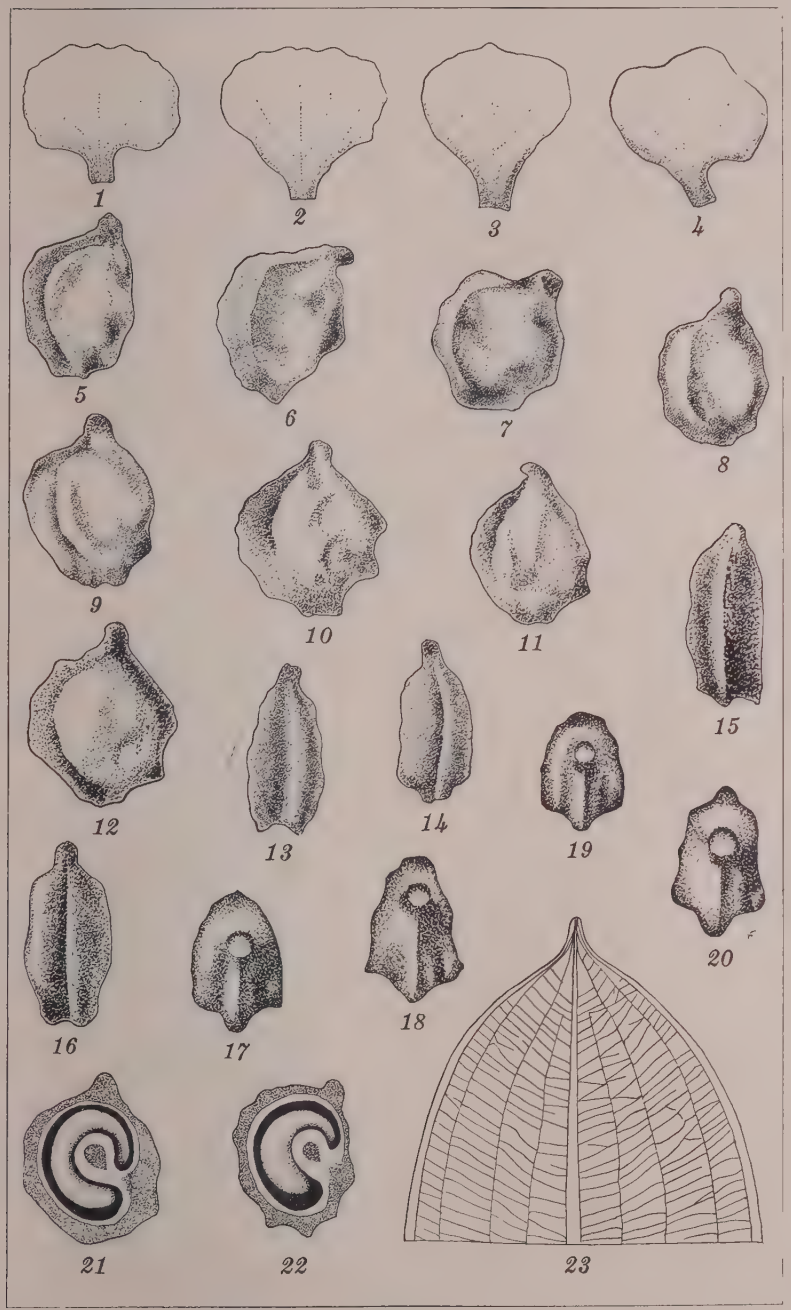

PLATE 11.

PLATE 12.

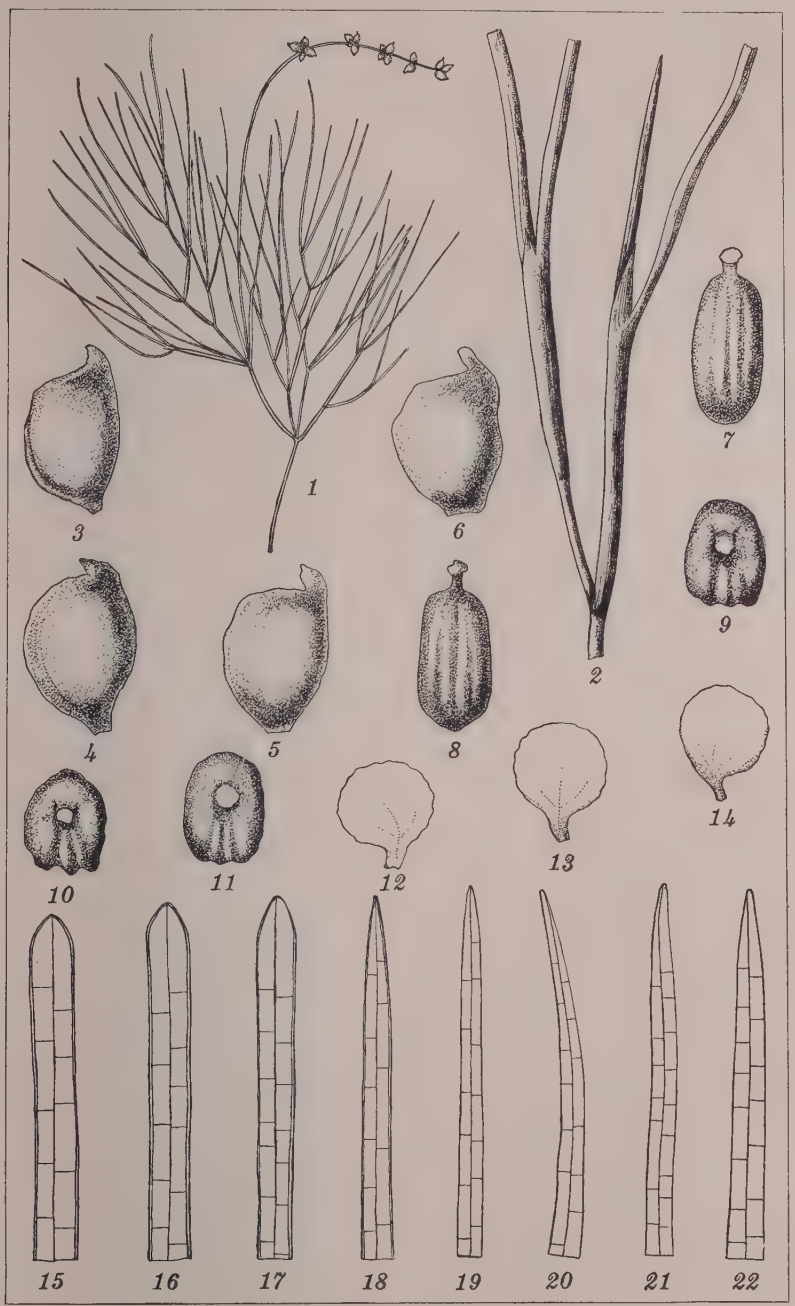

PLATE 13.

PLATE 14.

THE PHILIPPINE FAULT ZONE AND ITS RELATION TO PHILIPPINE STRUCTURE

By A. D. Alvir

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TWO PLATES

The Philippine Fault Zone[1] as conceived by the writer is obviously arcuate structure, extending from the northeastern coast of Alabat Island, across the narrow isthmus at the head of Ragay Gulf, through the center of Ragay Gulf to the western edge of Ticao Island, and the eastern coast of Masbate Island; thence to the sound between Biliran Island and northwestern Leyte, through Leyte to Cabalian Bay along the eastern side of Panaon Island, along the western escarpment of the Diwata Range in Surigao, to Pujada Bay and the eastern side of the peninsula (Davao Peninsula) which delimits the eastern coast of Davao Gulf. As traced it gives the impression of one continuous line, but it is probably a series of more or less connected faults properly termed a zone, and the line just sketched is probably where the greatest movements took place. There are, of course, branching faults at an angle to the main fault zone, the most obvious of which are in Leyte. One fault branches off from the main zone just west of the town of Leyte and follows a slightly curved line to the town of Ormoc, and may continue along western Leyte across the Mindanao deep into Gingoog Bay and along Pulangi River in Mindanao. Another fault, longer and more obvious, starts in the vicinity of barrio Oguis, about 23 kilometers north of the town of Sogod, and runs along the west side of Sogod Bay across the Mindanao Deep to the western side of Agusan Valley to Davao Gulf.

Davao Gulf is important because the block included between it and the main fault constitutes the graben now occupied by the Agusan Valley.[2]

[1] Willis, Bailey. Geological Observations in the Philippine Archipelago. National Research Council Bull. No. 13 (1937) 35–40.

[2] Smith, W. D., Geology and Mineral Resources of the Philippine Islands (1925) 283.

Speaking of the Philippine Fault Zone, Willis [3] states that the fault planes are vertical, that the horizontal displacement is large as compared with the vertical, and that the effect is that of rotation of the inner disc [4] within the outer rim, the former moving northwestward with reference to the latter. He fails to state his basis for this conclusion. It is presumed that his conjectures are based on the curvature and direction of the tectonic lines west of the fault zone, which could only result from stresses along the Philippine Fault Zone acting in a northerly or northwesterly direction.

However, the relative positions of several structures along the fault zone seem to provide evidence that the resultant relative movements have been in the opposite direction; that is, that the Eastern Philippine Rim [5] of Willis, or the outer rim, has moved to the north or northwest in relation to the inner disc. It is evident, however, that the inner disc has also moved to the northwest, but to a much lesser degree, apparently dragged by the outer rim along the Philippine Fault Zone.

EVIDENCES OF THE RELATIVE NORTHWARD DISPLACEMENT OF THE OUTER RIM ALONG THE PHILIPPINE FAULT ZONE

Conjectures of major geological structures based on long range observations are based mostly on the major topographic and bathymetric features of a very extensive area. We have an excellent plaster model relief map of the Philippines (Plate 1), showing topographic and bathymetric features, in which some very interesting structures along the Philippine Fault Zone can be observed.

At the head of Ragay Gulf, the Bicol Peninsula portion appears to have shifted about 25 kilometers to the northwest in relation to the Bondoc Peninsula portion, along the above-mentioned Philippine Fault Zone. Following this zone to the south gives rise to a very convincing piece of evidence. Ticao Island [6] appears to have been sliced from the eastern part of Masbate Island and shifted about 50 kilometers to the northwest. Both the western side of Ticao Island and the

[3] Willis, Bailey. Geological Observation in the Philippine Archipelago. National Research Council Bull. No. 13 (1937) 35.

[4] Loc. cit. The inner disc is the portion west of the fault zone and the outer rim is the portion east of the fault zone.

[5] Op. cit. p. 34.

[6] Smith, W. D. Geology and Mineral Resources of the Philippine Islands (1925) 282.

eastern side of Masbate Island have straight shore lines and escarpments, with rather deep water immediately below these cliffs. These straight shore lines fall in a remarkable alignment with the fault zone, and they are more or less coextensive.

In northern Leyte and central Leyte there is not much evidence of the horizontal displacement. Volcanic activity in Biliran Island and in Leyte proper has obscured this structure. However, in southern Leyte there is some evidence. At the head of Cabalian Bay a river flows in the direction of the fault after making a rectangular bend. The eastern side of Panaon Island is probably along the fault zone. A former eastern portion of this island may have been shifted to the north along the fault zone.

The eastern limit or wall of the Mindanao Deep is certainly in line with this structure and probably constitutes the continuation of the Philippine Fault Zone.

From Panaon Island and the eastern wall of the Mindanao Deep this structural line very decidedly continues apparently unbroken along the western shoreline of the Surigao Peninsula and along the fault scarp of the Diwata Mountains bordering the Agusan valley. Obviously the apparent movement of the outer rim is, again, to the north.

Block faulting of the Agusan depression [7] has made obvious the escarpment on the western flanks of the Diwata Mountains. It appears therefore that in the Agusan Valley, besides horizontal shifting, there have been great vertical movements along this fault.

As this structure is followed still further south to Pujada Bay we find more supporting evidence. The average and maximum relief of the region just west of the fault line is much lower than that of the region just east of the fault line. This region has apparently been affected by the block faulting which formed the Agusan depression. Portions of rivers are observed following the fault trace, and, incidentally, a case of river piracy is suspected. The eastern coast of Davao Peninsula is straight and precipitous and falls in line with the Philippine Fault Zone.

From the above it is evident that the portion of Mindanao east of the fault zone has shifted towards the north along the Philippine Fault Zone, attaining a horizontal displacement of about 75 kilometers.

[7] Op. cit. p. 283.

MECHANICS OF PHILIPPINE STRUCTURE

In considering the mechanics that apparently caused the initiation of the framework of our archipelago, and that eventually led to the present configuration, we shall discuss only those forces that are vital to our discussion and that have a direct connection. Of course there are the thrusts from the China Sea Deep and other basins and troughs within Philippine waters, which probably had to do with the original topographic and bathymetric configuration of basins and plateaus. These may have acted before, or at least simultaneously with, the forces that produced the arched lines of the mountain ranges of the archipelago.

Principal structural features.—The general topographic and bathymetric features of the Philippine Islands, as portrayed by the relief map, Plate 1*a*, shows, among other things, the following principal structural features:

A principal tectonic line of upwarp *A–A′* and a branch *A–A″* extends from the eastern coast of Luzon, through Bondoc Peninsula, Tayabas, through Masbate, Leyte, and Mindanao. This arcuate line is more or less a continuous mountain range or a zone of upwarp, convex to the east from Bondoc Peninsula, and roughly parallel to the edge of the Philippine platform. From the central part of Leyte this zone is apparently divided into two branches, one running through the Diwata Mountains of Surigao and the other along the western part of Agusan and Davao Provinces. This structure probably continues across Celebes Sea, to Celebes Island and Halmahera Island, Molucca Pass corresponding to the Agusan Graben.

Closely following the above-mentioned tectonic line is the Philippine Fault Zone *F–F′* with its branches *V–V′* and *Y–Y′*.

To the west of the line *A–A′* there are several arcuate tectonic lines of upwarp, emanating, as it were, from the main line A–A′. These are lines *c–c′*, *d–d′*, *e–e′*, and *n–n′* which run in a general southwesterly direction and are convex towards the east.

Line *B–B′* is certainly not a branch from *A–A′*. Moreover, it is the counterpart of the structure of *A–A′* on the opposite side of the platform.

East of the line *A–A′* we find only a few, short, and poorly developed lines of upwarp, but they have more or less a definite arrangement. Lines *g–g′* (Mambulao-Caramoan line) and *h–h′* (Batan Island Chain) are nearly but not quite parallel to both

line *A–A′* and the edge of the Philippine platform. Line *m–m′* in Samar, *k–k′* through Dinagat Island, and *l–l′* through Siargao Island bear more or less the same direction with a slight convexity to the west. Ranges made up principally of volcanoes are naturally not considered in this discussion. These include the Bicol volcanic range and Negros.

Mechanics.—An attempt will now be made to trace the development of the above-described structural features and the forces responsible for them.

It is quite evident that the tectonic lines west of the zone *A–A′* (Plate 1*a*) must have been produced by stresses acting in a northwesterly direction along the zone of *A–A′* or the fault zone *F–F′*, and that peripheral movement must have occurred in that direction. There is no doubt that thrusts from the China Sea Deep may have helped in the creation of these tectonic lines and in the degree of their curvature, especially as regards line *B–B′* (Zambales-Palawan arc), but these thrusts alone certainly could not have produced the peculiarities of our Philippine structure.

A consideration of the forces that probably acted on the archipelago is now in order.

There were thrusts from the China Sea Deep acting in an easterly direction. These thrusts were apparently not of the first magnitude since the area of the China Sea basin is comparatively small.

Then there were the thrusts from the Pacific Ocean acting in a general westerly direction. These were forces of the first magnitude, and since the center of the Pacific Ocean is to the southeast of the Philippines the forces may have had a direction some degrees north of west, about N 75° W.

And lastly, there were the forces from the northwest, the continental thrusts from Asia, which acted on a higher level than the oceanic thrusts, and affected northern Luzon more than the rest of the archipelago.

Taking into consideration the whole archipelago before the present configuration had been attained, it is believed that the initial structures produced were two long zones of upwarp or arching; one, *B–B′* (Plate 2), along the western edge of the Philippine platform and the other, *A–A′*, along the eastern edge. These zones would naturally be the first to be affected by the forces from the China Sea Deep and the Pacific Ocean. They probably had a smaller degree of curvature than that shown in the illustration. Line *B–B′* extends into Borneo and

line *A–A′* can be traced into the Celebes group by the alignment of islands across Celebes Sea.

Due to the heterogeneity of the earth's crust and to some irregularities around the rim of the Philippine platform, it is believed that some minor folds or upwarps related to the main structure may also have been initiated contemporaneously. Thus should be explained the Mindoro upwarp, and the irregular worn-down upwarp of Samar. The last named had more reason to be so on account of the rather large area of the platform to the east of the Main eastern structure *A–A′* (Plate 2).

To sum up, the Philippine Archipelago had then quite a simple structure. There were two main lines of upwarp, which were parallel in the northern third portion and which diverged to the south more or less along the edge of the platform. Between these two main lines of upwarp there was a depression or downwarp, which points to the origin of the Central Plain of Luzon and the Cagayan Valley, at that time one integral structural unit. Towards the south this central downwarp may have been accidented by the presence of the original basins and plateaus of irregular outline but without the present configuration of ranges.

These zones of upwarp were zones of weakness and relief of pressure which must have induced the liquefaction of igneous rocks under them, and consequently there must have been intrusions into the weakened zones.

The Eastern Philippine Rim [8] is a wedge that is wide to the north, bounded on the west by the Philippine Fault Zone, and on the east by the submarine fracture or fault of the Philippine Deep, *PD–P′D′*. It probably had a structure similar to the main Philippine structure on a much smaller scale. The Bicol Peninsula was a downwarp or trough between the main eastern structure *A–A′* (Plate 2) and an old upwarp axis *W–W′* which at present is not determinable.

Old plutonic rocks have been found in small areas of low elevation in the Bicol Peninsula. They are probably remnants of older mountains which have been eroded and then covered by volcanic products and sedimentation. Granite is found in the Paracale-Mambulao area, in a small area in Tagcauayan east of the head of Ragay Gulf, an area about 5 kilometers north

[8] Willis, Bailey. Geologic Observations in the Philippine Archipelago. National Research Council Bull. No. 13 (1937) 34.

of Tagcauayan, in Polillo, and in Catanduanes islands. Peridotite is also found in the Paracale-Mambulao area, in Caramoan Peninsula, in the Batan Island Chain, and in other isolated spots. These plutonic rocks must have been brought up to the surface by continued upwarping and erosion. While these rocks are now found along the Mambulao-Caramoan axis, it is nevertheless believed that the formation of this small tectonic axis is more plausibly explained by the buckling up of the wide northern end of the wedge due to the northward movement of the outer rim. The same holds for the upward of the Batan Island Chain and the low ridge along the northern coast of Samar. In Samar there was a depression or downwarp between the main fold *A–A′* and the Samar upward. This smaller structure of the Eastern Philippine Rim was probably continuous from Lamon Bay to eastern Leyte and ends there, at the edge of the platform.

We thus have the origin and structure of the Bicol Peninsula, whose downwarp, now mainly covered by volcanic products and Tertiary sediments, finds its continuation between Leyte and Samar.

Development of the present configuration.—With the initial structure of our archipelago as outlined above, and the forces acting on it as described earlier, we shall now endeavor to follow the development to its present general configuration.

The oceanic thrusts from the Pacific Ocean continued to act in a direction about N 75° W. Even if these forces were acting in a general westerly direction, the results would not have differed materially, since the tendency of the wedge, the outer rim, would be to move to the north if squeezed.

These forces must have had components tangential to the curved structure *A–A′* (Plate 1*a*). This structure, a curved zone of weakness, was, from the circumstances and its position, the most vulnerable to the forces acting. It is also evident that the most unstable portion of the Philippine platform was (and probably still is) the Eastern Philippine Rim. (Northern Luzon was also very unstable and will be taken up later.)

Consequently there was a very strong tendency for the Eastern Philippine Rim (the outer rim) to move to the north along the zone of weakness *A–A′* (Plate 1*a*), and along the submarine fracture *PD–P′D′* of the Philippine Deep. This tendency must have set up great stresses along the zone *A–A′* (Plate 1*a*) acting towards the northwest. Movement of the mass in that direction must have been accomplished, the outer rim dragging,

as it were, the inner disc, and causing it to effect a rotatory or peripheral counterclockwise movement. Aided by the lateral forces, this peripheral movement acted as a trigger, and initiated the auxiliary or secondary tectonic lines *c–c′* along Tablas and Antique; *d–d′* along the western prong of Masbate; *e–e′* along Cebu and the Zamboanga-Jolo area; and *n–n′* along northwestern Leyte, Bohol, and Siquijor. Further movements increased the curvature of the lines, and have displaced some of them. Lines *c–c′* and *d–d′* were evidently displaced by an east-west fault, along northern Panay. Line *o–o′* through Romblon and Sibuyan appears to be a branch from line *c–c′*.

Minor lines, in the outer rim, like *k–k′* along Dinagat Island and *l–l′* along Siargao Island, may have been initiated also by the same northward movement coupled with the resistant stresses along the line *A–A″*.

The movement towards the north of the wedge or the outer rim must have produced new axes of upwarps more or less transverse to the direction of movement at the wider northern part of the wedge. As a result the Mambulao-Caramoan axis, the Batan Island Chain axis, and the low ridge of northern Samar were formed. To this northward movement of the wedge and to the consequent buckling up of the crust along the edge of the platform within the wedge, may also be attributed the formation of the Polillo Island group and Catanduanes Island and the bulge of the platform north of the Bicol Peninsula.

The Philippine Fault Zone.—The tendency of the outer rim to drag the inner disc to the north along the weakened zone *A–A′* culminated in sudden movements along a series of closely associated fractures, thus initiating the Philippine Fault Zone, immediately east and closely following the line *A–A′* (Plate 1*a*).

These sudden displacements along the fault zone must have relieved the compressive stresses momentarily, and normal faulting may have then taken place, specially along subsidiary faults. The inner disc may have even rotated back to some degree. Subsequently the compressive stresses must have built up again, and the outer rim must have tended to move northward once more, dragging the inner disc with it until the elastic limit had been reached, when sudden displacements must have again occurred along the planes of the fault zone, causing violent earthquakes. This process must have been repeated over and over again, and has probably persisted to the present time, as

may be gathered from the recent tectonic earthquakes which affected Alabat Island and western Bicol Peninsula in 1937, and the many earthquakes recorded each year at Agusan Valley.

From southern Leyte the Philippine Fault Zone has an important secondary structure, which extends down through eastern Mindanao and probably into the Celebes Group. It is a huge structural unit, but it is termed secondary, with reference to its origin. Reference is made to the apparent branching of the upwarp zone *A–A′* (Plate 1*a*) along both sides of the Agusan Valley; and its accompanying branch fault *v–v′*. It is believed that these two upwarp branches originally constituted one wide zone of upwarp whose main axis may have occupied Agusan Valley. The stresses which tended to push the outer rim wedge to the north and which resulted in the fault zone *F–F′* may have also produced other lines of relief in this wide zone, among them faults *V–V′*, and *Y–Y′*. Periodic reactionary tensional stresses obtaining after sudden displacements along the Philippine Fault Zone have probably caused the Agusan Valley Block to sink, in relation to its sides, along its many fault planes, producing mainly a graben.

It is believed, moreover, that the structure of Agusan Valley is not as simple as an ordinary graben. It appears likely that there are several north-south faults on either side of Agusan Valley as well as within the valley. The movements along these faults have not always been of the same magnitude, and consequently there appear to be several horsts and grabens within the valley block as well as on either side. Nevertheless, the cumulative effect has been the relative sinking, as a whole, of the Agusan Valley Block.

This structure is reflected across the Celebes Sea, the western branch following a string of islands into the northern prong of Celebes Island, the eastern branch following another string of islands into Halmahera Island, and the space between these two strings corresponding to the Agusan Valley Graben.

In eastern Mindanao the cumulative total relative displacement of the outer rim wedge along the fault zone is about 75 kilometers, and was roughly measured by the length of Davao Peninsula and Surigao Peninsula along the fault zone. The probable total displacement of Ticao Island in relation to Masbate is about 50 kilometers. In Tayabas, across the narrow neck at the head of Ragay Gulf, the relative total displacement is about 25 kilometers. It is apparent that the total displace-

ment is less and less towards the north, as may be expected when we consider that the fault zone probably ends just beyond Alabat Island, but may continue along the eastern coast of Tayabas.

From the foregoing it is clear that great northwest stresses have been acting and are still acting on the whole of southern Luzon, due to the push from the eastern Philippine Rim. These severe stresses must have found relief either by folding, thrust faulting, or by mass displacement along some major fracture. Some additional folding may have been produced in the Sierra Madre Range. Of thrust faulting we have at present no data. The Philippine Fault Zone may continue along Eastern Tayabas. But most of the relief must have been found in displacements along the central fault (X–X') of Luzon. It is believed that northern Luzon [9] has moved to the southeast or that southern Luzon has moved to the northwest, along the central fault X–X'. From a consideration of the forces acting on Luzon it is more probable that both portions of Luzon have moved in opposite directions along the central fault.

Thus the island of Luzon has been and probably still is under the influence of a couple: forces from the southeast acting on southern Luzon and forces from the northwest acting on northern Luzon. The above contention is supported by the observations of Willis on the Abra thrust [10] along the western part of northern Luzon, and the apparent northwestward movement along the Philippine Fault Zone.[11] Relief from the stresses set up by this force couple is accomplished by sudden displacements along the Central Fault X–X' as evidenced by tectonic earthquakes whose origin has been traced to this fault.

Willis doubts the existence [12] of the Central Fault X–X'. However, the very definite trace of the fault nearing Dingalan Bay, and the absence of discernible alluvial fans along the fault trace prove that there is a fault and that it is still active; the sinking of the Central Plain block is keeping pace with

[9] Alvir, A. D. A theory on the major tectonic structure of the Island of Luzon, Philippine Islands. Third Pacific Science Congress Proceedings. Tokyo, Japan 1 (1926) 451.

[10] Willis, Bailey. Geologic Observations in the Philippine Archipelago. National Research Council Bull. No. 13 (1937) 17, 18.

[11] Op. cit. p. 35.

[12] Op. cit. pp. 20, 21.

the deposition of the alluvial fans. Moreover, observations across this fault trace in different places confirm its existence.

SEISMOLOGICAL CONSIDERATIONS

The most destructive earthquakes are of tectonic origin and are produced by sudden displacements along fractures. Of great interest to us, therefore, are the main fractures which are active today.

The most unstable portions of the Philippine Platform today are the Eastern Philippine Rim, northern Luzon, and to a lesser degree, southern Luzon; and the most active main fractures are the Philippine Fault Zone, *F–F′* with its branches, the Philippine Deep Fracture *PD–P′D′*, and the Central Fault of Luzon, *X–X′*. It is believed that the greatest part of crustal readjustments occur today along these three lines, and that displacements along other fractures are merely subsidiary.

ILLUSTRATIONS

PLATE 1. The Philippine Archipelago

PLATE 1*a*

The Philippine Archipelago, showing the present structural lines. Solid lines are tectonic lines of upwarp or folding. Broken lines are fault traces. *A–A′*, principal line of tectonic upwarp; *A–A″*, branch line of tectonic upwarp; *B–B′*, counterpart of *A–A′* on opposite side of platform; *F–F′*, fault zone; *PD–P′D′*, submarine fracture *c–c,′ d–d,′ e–e,′ n–n,′* tectonic lines of upwarp; *g–g,′* Mambulao-Caramoan line of upwarp; *h–h,′* Batan Island Chain line of upwarp; *k–k,′* Dinagat Island Line of upwarp; *l–l,′* Siargao Island line of upwarp; *m–m,′* Samar line of upwarp; *o–o,′* branch from line *e–e′; p–p,′ v–v,′* branch of Philippine Fault zone; *x–x,′* central fault; *y–y,′* Branch of Philippine Fault Zone.

PLATE 2

The Philippine Archipelago, showing the initial zones of upwarp. *A–A′*, principal line of tectonic upwarp; *B–B′*, counterpart of *A–A′* on opposite side of platform; *M–M′*, Samar line of upwarp; *P–P′*, *W–W′*, old upwarp axes.

PLATE 1–a. The Philippine Archipelago—Showing the present structural lines. Solid lines are tectonic lines of upwarp or folding. Broken lines are fault traces.

PLATE 1–a. The Philippine Archipelago—Showing the present structural lines. Solid lines are tectonic lines of upwarp or folding. Broken lines are fault traces.

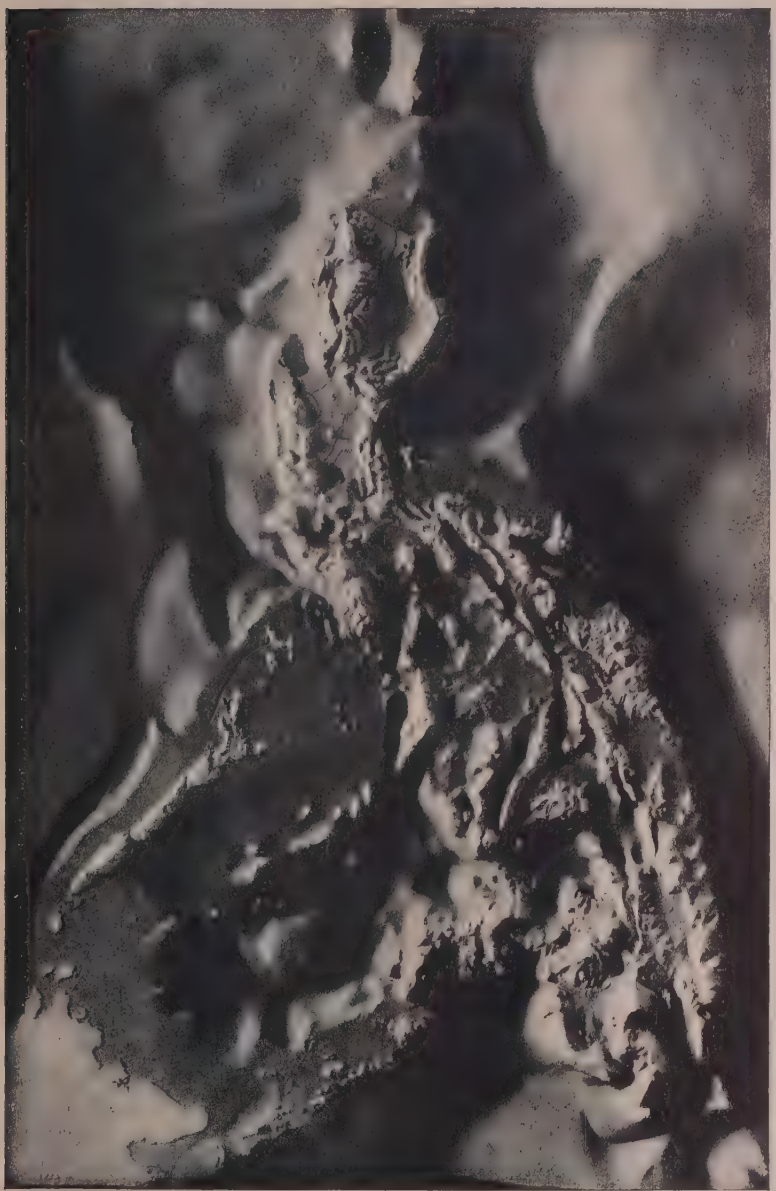

PLATE 1.

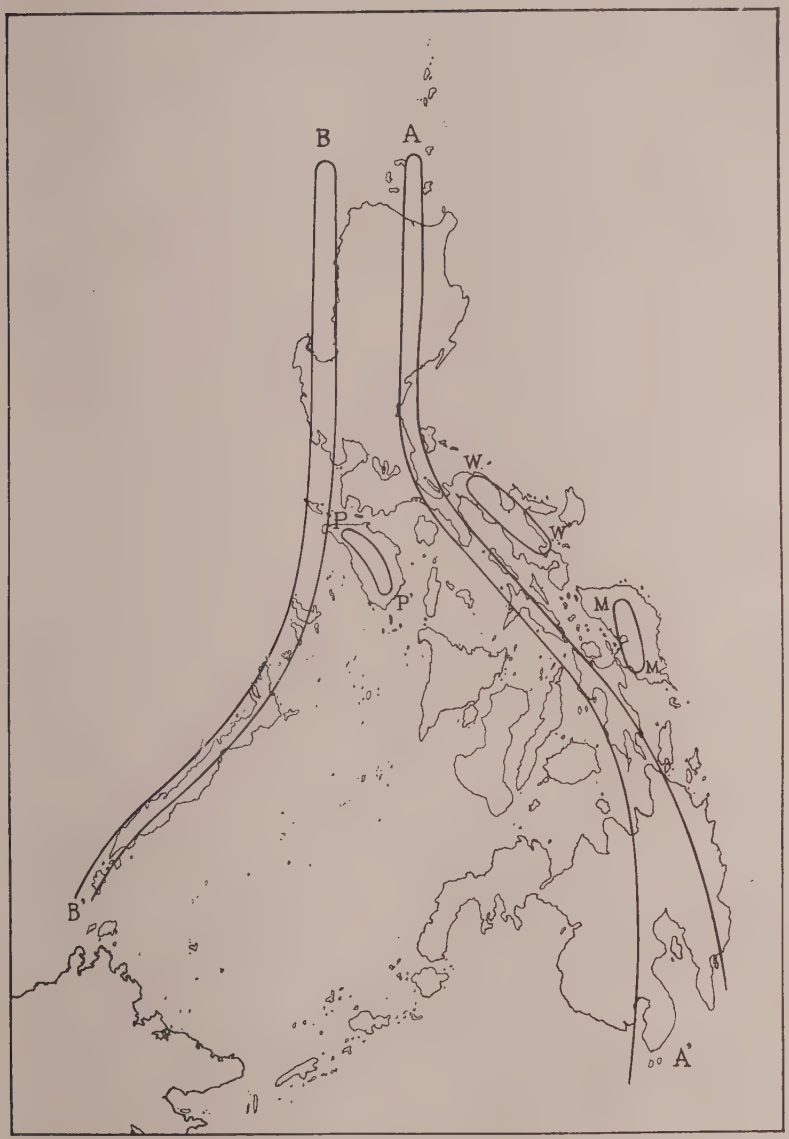

PLATE 2.

THE PROBABILITY OF COMMERCIAL OIL POOLS IN THE CENTRAL PLAINS OF LUZON

By A. D. Alvir

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Oil is a strategic product vitally needed by warring nations as well as by peaceful countries. It is the essence of modern warfare; it is the essence of industry. In times like the present the search for oil and the fight for oil is intense and vital.

Cognizant of the importance of oil, President Quezon instituted a geological reconnaissance throughout the Philippines for the purpose of ascertaining probable oil localities.

We produce no oil, yet we are surrounded by oil-producing countries. Oil seeps have been observed in many islands. The Vigo Formation, known to be the mother bed of oil, is widespread in our country. Studies and exploratory work have been made in Bondoc Peninsula, Leyte, Cebu, and Mindanao. Recent work by the National Development Company has covered practically all likely areas. Seismic prospecting is about to begin in Panay. At Daan-Bantayan, northern Cebu, the Far East Oil Company has drilled to a depth of about 6,000 feet. This is one of the likeliest of localities. In the early 1920's the Richmond Petroleum drilled several holes in Bondoc Peninsula. Recently the Far East Oil Company drilled a hole there. The results so far are not encouraging.

To this vigorous search of oil the present writer wishes to contribute his little "grain of sand."

Methods in the search for oil.—Before the application of practical oil geology wildcatting [1] was the regular procedure. The percentage of dry wells was very high. With the application of geology the percentage of successful wells began to rise. With the progress made in oil geology, especially along the lines of micropalæontology and sedimentary petrology, and the use made of structural contour maps, palæogeography, and other data, more complex and hidden structures have been determined and new fields discovered and made productive. And now geophysical methods are being used, mainly (*a*) with the aid of the

[1] Today "wildcatting" means drilling a still unproductive area if the geology has been studied and found favorable. "Wildcatting" used to mean drilling an unproductive area without benefit of geology.

torsion balance or determination of gravity anomalies, (*b*) with the aid of the seismograph, and (c) by electrical methods. These methods have lead to the discovery of hidden structures. Gone are the days of wildcatting and counted are the days of simple geological structures. In the Philippines, however, there is still room for the discovery of simple structures, such as anticlines, which are evident from the outcrops.

Nowadays the geologist, in examining an area, looks essentially for the following conditions:

1. An area of little orogenic movement, mainly plains or undulating plains, former basins of deposition, underlain by sedimentary rocks, especially shales, rich in organic materials.

2. Reservoir rocks, such as porous sands, sandstones, conglomerates, or cavernous limestones of sufficient thickness to hold commercial quantities of oil and gas.

3. Relatively impervious cap rocks, such as shales and compact limestone to act as seals above the reservoirs.

4. Traps for oil accumulation, such as anticlines, domes, unconformities, lenticular sands, and the like.

5. Hydraulic conditions, since water pressure helps in the accumulation of gas and oil.

The central plains of Luzon.—Probably no other area in the Philippine Islands fulfills the above conditions as fully as the central plains of Luzon.

The central plains of Luzon show no signs of past or present orogenic movements. The few scattered mountains within their limits are only volcanic necks, and these are few and far between. This region up to Pleistocene times has been an area of deposition, bordered on either side by uplands, probable islands during pre-Pleistocene times. We should therefore expect sediments of all Tertiary times represented here. This assumption is corroborated by the great thickness of sediments along Naguilian Road, a block raised in post Pliocene times. As a matter of fact, in a conversation with Mr. Beltz, chief geologist of Socony, the present writer was told that the geologists of this company have verified the presence of the Vigo Shales on both sides of the Central Plains. The Vigo Shales constitute the mother bed of oil in the Philippines.

Good Reservoir rocks are probably not lacking in this area because of its proximity to the mountains which were high islands when the area was a basin of deposition. We should expect therefore a good proportion of coarse sediments and lenticular beds.

Good cap rocks, shales, above the Vigo Horizon, have been noted on both sides of the Central Plains.

The structure of the Central Plains tends to be disregarded as a likely structure for oil accumulation, it being a geosyncline. It is a geosynclinal area of deposition that has recently become dry land as a result of an uplift of the land mass. But pressures acting from the east[2] must have slightly folded the strata in this geosyncline producing anticlines and synclines in the major geosynclinal structure. As a matter of fact, folds have been noted in Tarlac in the Pliocene tuffs. It is therefore believed that broad anticlines exist below the central plains, anticlines broad enough to trap oil in commercial quantities. Moreover, it is believed that lenticular sands must abound here due to the proximity of the deposition to the existing strand lines at different times.

The structure being a geosyncline, the upturned edges of the sediments should be and are found flanking the mountains on either side, dipping into the plains. Consequently it is easy to see that water will be taken in along these upturned edges and should help in the accumulation of oil in the traps below the plains. The oil may even be flushed into the traps. In other words the conditions are right for hydrostatic pressure and gushers may result when this region is drilled.

A few years ago the writer made a report on an oil seep at Guimba, Nueva Ecija Province. The oil could not be seen until about 4 meters of water had been bailed out of a well. Then one could see the oil spreading over the water surface at the rate of a couple of inches per second.

Studies[3] of gravity anomalies in the Central Plains have shown the Central Plains to be a probable petroliferous area.

CONCLUSION

From the above it is believed that the central plains of Luzon is one of the most favorable areas for commercial oil pools in the Philippines and it is hoped that the National Development Company will soon have seismic work done on it to determine the hidden structures. And these hidden structures should be drilled for oil.

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[2] This structure is explained in the preceding paper. This issue, pp. 411–423.

[3] Pelaez, Vinicio. Probable petroliferous areas in the Philippines, Nat. Appl. Sci. Bull. (2) 7 (1939) 169–184.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Standard Chemical and Technical Dictionary. By H. Bennett. New York, The Chemical Publishing Company, 1939. 638 pp. Price, $10.

This is a very handy chemical dictionary that presents useful information very briefly. It gives names and formulas of chemical compounds, together with identification data. For instance:

Lauric acid (dodecanoic acid). $CH_3(CH_2)_{10}COOH$; n. w. 200.19; col. need. f. al; m. p. 44; b. p. 220^{100}; l. w.; s. al.

A list of abbreviations is given in the preface. Also included are: directions for using the dictionary; prefix names of organic radicals; pronunciation of chemical words; and a condensed, though very interesting, account of the nomenclature of organic chemistry.

Definitions of expressions like "iodine number" are clear and concise. Many popular terms like "cosmic rays," producer gas," and the like, are included. However, we did not find "octane number."

The dictionary concludes with a rather complete list of both abbreviations and contractions, together with the Greek alphabet and symbols as well as mathematical and apothecary symbols.—A. P. W.

The Detection and Identification of War Gases. Notes for the Use of Gas Identification Officers. 1st American edition. New York, Chemical Publishing Company, Inc., 1940. 53 pp. Price, $1.50.

This little book of 53 pages gives complete information of the physical and chemical properties of war gases. The grouping of these gases on the basis of the effects they produce on the human body furnishes a very convenient way of identifying them and studying their dangerous properties. Two general methods of testing, the subjective and the objective methods, are described and discussed in a comprehensive and simple

manner. In chapter IV the book gives complete instructions on the duties and responsibilities of gas identification officers, as well as the method of testing the more important gases, such as those used during the Great War. The book is a product of experience and therefore is very valuable to humanity in general and to those interested in chemical warfare service in particular. It closes with two appendices, giving a list of testing equipment and its use, and a blank form for reporting results of tests. Taking into consideration the prevailing chaotic condition of the world, the publication of this book may be considered very timely.—R. H. A.

Modern Cosmeticology; the Principles and Practice of Modern Cosmetics. By Ralph G. Harry. New York, Chemical Publishing Company, Inc., 1940. 288 pp., illus. Price, $5.

This book, dealing with the manufacture of modern cosmetics, includes information on the dermatological principles underlying the use of cosmetics, and thus gives the reader an idea of the choice of raw materials for the product. It also gives the histology of the skin, the hair, and the nails. The problem of skin absorption, the efficacy of vitamin and hormone preparations, and the question of allergy and dermatitis are discussed. The book is not a mere collection of "cook book formulae," inasmuch as the author has only included those formulas that have been tested and proven to be satisfactory, and those which he has evolved through slight variation of constituents to obtain a variety of products to suit his own purpose. Comprehensive information with regards to the characteristics, properties, and the effects of creams, make-up preparations, lotions, and shaving and dental preparations is given.

This book is a valuable guide to manufacturers of cosmetics, chemists, and those interested in the small-scale production of such preparations.—M. R. A.

Varnish Making. By the Oil and Colour Chemists' Association. New York, Chemical Publishing Company, Inc., 1940. 231 pp., illus. Price, $6.

This book is a symposium on varnish making, prepared by the Oil and Colour Chemists' Association. It is a very interesting and a valuable publication for students, professional chemists, and manufacturers engaged in the making of varnish.

The various papers comprising this publication, which were written by different authors, deal with the important physical and chemical properties of natural and synthetic raw materials

used in the manufacture of varnish. The discussions, especially on some of the most recent methods and procedures employed in the modern treatment and manufacture of varnish products, prove to be an important feature of this book. Other subjects and problems commonly met with in factory operations, such as: factory hazards, fume condensation, filtration and aging of varnishes, and methods of heating and accurate measurements of temperatures are also discussed in this book. The history of varnish manufacture, aside from its literary value, is very instructive.—T. D. J.

A Dictionary of Metals and Their Alloys; Their Composition and Characteristics. Edited by F. J. Camm. New York, Chemical Publishing Company, Inc., 1940. Price, $3.

This is a handy, concise metals handbook in dictionary form. It includes salient and useful facts regarding every known metal and nearly every type of commercial alloy, and contains authoritative information in easily understandable manner, as well as adequate cross references. In addition to the dictionary, the book also contains special sections on hardening, case-hardening and tempering, electro-rust-proofing, and tables. It is highly recommended to all metallurgical scientists and students as a valuable addition to their collections, and to all scientific libraries as a reference tool.—J. B. B.

The Book of Diamonds: Their Curious Lore, Properties, Tests and Synthetic Manufacture. By John Willard Hershey. New York, Chemical Publishing Company, Inc., 1940. 142 pp., pls. Price, $2.

This book is primarily a popular treatment of diamond lore. The author traces the history of the diamond from the earliest times to the present and gives an insight into the three great diamond districts of the world, India, Brazil, and South Africa. His chapters on properties and tests for diamonds and how to buy diamonds are very instructive. The average reader will be entertained by the author's account of the stories connected with famous diamonds and other gems. A chapter on synthetic diamonds as prepared at McPherson College is appended. The author has certainly fulfilled his promise of making this book a pleasant pastime.—J. B. B.

The Meteorological Glossary. 3d edition. 1st American edition. New York, Chemical Publishing Company, Inc., 1940. 251 pp., illus. Price, $3.

The third edition of the Meteorological Glossary is to be recommended because of its completeness. Terms of recent origin

are explained briefly, and references which enable one to obtain further detailed information are given. Mathematical terms which occur in meteorology have excellent definitions together with short derivations. At the end of the book there is a list of equivalent words in various languages, a valuable help to a student of meteorology who has difficulty in finding meteorological terms in scientific dictionaries.

The following remarks concerning Philippine meteorology should be noted. Under the word "Baguio" the last sentence should be modified. It is not clearly understood just what is meant by the "class of cyclone which is especially associated with these islands, occurring from July to November." Under the word "cyclone" there is a table (page 59) giving the number of tropical cyclones that occurred in various parts of the world. The total number of frequencies of typhoons in "Cyclones of the Far East," by Jose Algue, S. J. (page 86) has been copied and copied correctly, but these frequencies referred to the Far East and not merely to the China Sea, as indicated on page 59 of the Glossary.—B. F. D.

Rubber Latex. By H. P. Stevens and W. H. Stevens. 1st American edition. New York, The Chemical Publishing Company, Inc., 1940. 224 pp., front., illus. Price, $2.

Rubber latex supersedes the pamphlet written by Stevens and Stevens on the same subject. The book gives general information to those having little or no specialized knowledge of latex. Pictures are included to show the methods of treating latex and of manufacturing rubber goods. There are also microphotographs of rubber latex particles.

About half of the book is devoted to British patents on latex. Although no United States or foreign patents are cited, their sources are given. The following chapters are discussed: The source and production of latex; conversion to rubber; the properties of latex; composition, stabilizing, and coagulation of latex; concentration of latex; the manipulation and compounding of latex and latex paste; stabilization of latex for industrial purposes; vulcanization of latex and latex products; manufacturing from latex by dipping and electrodeposition; applications and products of latex; the marketing of latex and patents. Although written for the general public, the book should also find a place in the libraries of those engaged in the rubber industry. A bibliography and index are included.—G. O. P.

Propagation of Plants. By M. G. Kains and L. M. McQuesten. New York, Orange Judd Publishing Company, Inc., 1938. 555 pp., illus., tables. Price, $3.50.

This richly illustrated book on the propagation of plants is a very handy guide to the professional as well as the amateur propagator, be he a nurseryman, experimenter, greenhouseman, researcher, or a teacher. The authors were able to condense all the important discoveries and improvements in the methods of the multiplication of plants achieved during the last few years. They were able to explain all the technical and scientific terms in a manner sufficiently simple to meet the needs of even a beginner in the science of plant propagation. The vividness of the presentation of the subject matter as well as the conciseness and nice choice of words in portraying to a layman the whys and hows in plant propagation will meet the demands of even the most scrutinizing of plant propagators.—J. B. J.

Gardening Without Soil. By A. H. Philips. New York, Chemical Publishing Company, 1940; London, C. Arthur Pearson, Ltd., 1939. 139 pp., illus. Price, $2.

This book introduces two methods of gardening without soil; namely, water culture and aggregate culture. Hydroponics as an analogous term to water culture is also known as chemiculture, aquaculture, tank farming, tray horticulture, and, more or less facetiously, as bath-tub farming. Aggregate culture is a term used to cover the growing of plants in mineral aggregates, which may range from sand to granite chips or gravel to cinders. The author gives unbiased judgment on the merits of the two systems. Finding that water culture is more practical than aggregate culture, the author dwells a great deal on the discussion of the former. His style is simple and well within the bounds of the layman's scientific understanding.

This manual gives a complete review of all the methods practicable in hydroponics, and provides a comprehensive guide to all principles involved in soilless culture. It treats the subject from all angles, giving the amateur soilless gardener an opportunity to know all the vital factors necessary in the accomplishment of his aim. The chapter dealing on "doctoring the plants" is especially interesting to the soilless culturist, as it helps him diagnose nutritional ills in growing plants and thus eliminating as much as possible "chlorosis."

This little book is useful as a manual for those who wish to try hydroponics as a hobby.—J. T. S.

Intermediate Biology. By W. F. Wheeler. New York, Chemical Publishing Company, Inc., 1940. 530 pp., illus. Price, $6.

The larger majority of books written on living organisms pertain exclusively to either botany or zoology, dividing biology into two independent sections. This arrangement is unfortunate, for it is apt to cause the student to overlook "the similarities between the groups of living organisms and the general principles which apply to all." This book aims to overcome that tendency. By a wise selection of material, the author leads the student step by step to a recognition of "the fundamental attributes, formal and functional, of living organisms, with the discovery of their essential uniformity, frequently masked by superficial diversity."

The book is up-to-date in the discussion of biological principles. It is divided into seven parts, of which the first two are introductory and deal with the anatomy of well-selected types of plants and animals. The other parts take up in a comparative manner their cellular structure, physiology, development, inheritance, evolution, and ecology. A noteworthy feature is the inclusion of "practical work" at the ends of many of the chapters. This arrangement helps to make the subject more instructive and more interesting.—M. T.

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